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## Developmental changes in temporal patterns during supported walking in infants

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### ***published in***

Journal of Sport and Exercise Psychology  
2004

### ***document version***

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

### ***citation for published version (APA)***

Buzzi, U. H., Ledebt, A., & Savelsbergh, G. J. P. (2004). Developmental changes in temporal patterns during supported walking in infants. *Journal of Sport and Exercise Psychology*, 26, S46-S46.

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JOURNAL OF SPORT & EXERCISE PSYCHOLOGY, 2004, 26(Suppl.), S25–S206  
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### ORAL AND POSTER

#### **Perceived Belonging in Sport Scale: Construct and Concurrent Validity**

Allen, J.<sup>1</sup>, S. Kozub<sup>2</sup>, and H. Hall<sup>2</sup>. <sup>1</sup>University of Waikato; <sup>2</sup>DeMontfort University

Feeling connected with significant others has long been recognized as a central aspect of human motivation (e.g., Atkinson, 1964; Bowlby, 1969; Maslow, 1954; Rogers, 1951). However, the construct of belonging has received little attention from sport motivation researchers apart from a description of social motives for involvement and social sources of enjoyment (e.g., McCullagh, Matzkanin, Shaw, & Maldonado, 1993; Scanlan & Simons, 1992). Recently, Allen (2003) proposed a model of social motivation in sport in which belonging was conceptualized as the energizer of goal directed behavior in social contexts such as sport. This line of research is limited by the lack of a sport-specific measure of perceived belonging with demonstrated psychometrics. Allen began to address this issue by modifying a measure of perceived belonging in school (Goodenow, 1993) for the sport setting. However, Allen used only 11 items from the original scale, found problems with several items, and examined concurrent validity with only one variable—sport interest. Therefore the purpose of this study was to further develop and examine the construct and concurrent validity of the Perceived Belonging in Sport Scale. Participants ( $N = 259$  university students, ages 18–37 years,  $M = 20.31$ ,  $SD = 2.10$ ) completed a questionnaire assessing perceptions of sport belonging (20 items), satisfaction, cohesion, intrinsic and extrinsic motivation, and social self-esteem. Confirmatory factor analysis provided support for a shortened version of the PBSS. Perceived belonging was also related to satisfaction, cohesion, intrinsic and extrinsic motivation, and social self-esteem in a theoretically consistent manner, supporting the concurrent validity of the scale.

#### **Sensorimotor Integration During Locomotion Toward a Target in Parkinson's Disease**

Almeida, Q.J., J.S. Frank, E.A. Roy, and M.S. Jog. University of Waterloo

Movement impairment in Parkinson's disease (PD) has typically been explained as a motor output problem. Recent research (Adamovich et al., 2001) on upper limb target-oriented movements suggests this impairment may be due to difficulty integrating proprioceptive and visual inputs. We attempted to better evaluate the dopaminergic role in sensorimotor integration by comparing differences in a large within-subject sample of PD patients while "On" (approx. 75 min post-drug administration) and "Off" (at least 12-hr drug withdrawal) of their dopaminergic medications ( $N = 25$ ). The present experiment focused on two main objectives: (a) to determine whether a deficit in sensory integration may contribute to gait impairments typically observed in PD; and (b) to examine the influence of dopamine replacement therapy on sensorimotor integration while moving toward a target. As a baseline, healthy age-matched controls were also tested on the same protocol. All participants walked at a self-selected pace on a Gait-Rite carpet in 5 conditions of darkness: (a) baseline—no target; (b) to a remembered target; (c) to a remembered target with light on chest for body position awareness; (d) with vision of a lit target, also with light on chest; and (e) pushed in a wheelchair to remembered target. Final position accuracy (measured by 2-D radial error) revealed a main effect for group, suggesting that PD patients Off their medications moved to targets with less accuracy, but approached the accuracy of healthy

participants when in the On state. Both PD and healthy improved their accuracy with availability of concurrent vision and proprioception (condition D). Interestingly, PD Off have the most difficulty moving toward remembered targets and are especially affected when proprioception is completely removed (wheelchair), thus ruling out that these effects are memory-related. These results suggest that the basal ganglia are not specifically involved in visuoproprioceptive integration, since it does not appear to be impaired in Parkinson's disease. However, the dopamine system may be involved in utilizing proprioception to guide oneself toward a target during locomotion. Furthermore, gait kinematics were also analyzed and support the notion that when proprioception is manipulated, motor control changes can be quantitatively identified while moving toward a target.

*Supported by NSERC*

### **Explanations for Over- and Underestimating Imagined Movements**

Ammar, D., and C. Gabbard. Texas A&M University

A growing body of evidence suggests that motor ideation (imagery) involves several of the same mechanisms as motor planning and execution. A common observation in studies of imagined compared to actual movement in a reaching paradigm is the tendency to overestimate (Bootsma et al., 1992; Carello et al., 1989; Heft, 1993; Mark et al., 1997). Of the studies noted, reaching tasks have been performed in the midline range with visual information transmitted via both eyes open. In the present study, strong right-handers were asked to judge whether imagined visual targets, projected onto a table surface for 150 ms, were reachable or out of range. In addition to 7 random target distances at the midline, the same presentation was projected in right- and left-visual fields. Our findings at the midline support those of previous studies, that is, the tendency to *overestimate*. In regard to visual field conditions (RVF and LVF), with information being transmitted to the contralateral hemisphere only, participants *underestimated* their reachability. These findings are discussed in consideration of the multiple factors, which may explain such behavior as compared to actual reachability, such as use of visual information, mental strategy, and postural state. Underlying our intent with the study of imagined compared to actual reachability is the wish to gain a better understanding of the cognitive level of action processing.

### **Neural Mechanisms and Motor Preparation**

Anson, J.G., B.I. Hyland, J.R. Wickens, and D.F. Hight. University of Otago

In single hand responses, reaction time (RT) is shorter when information about movement direction rather than extent is precued. In the present study hand and extent were the manipulated precue variables. In addition to RT, electrophysiological measures (EEG and EMG) were recorded to examine the association among changes in brain electrical activity, muscle activation, and RT. A two-hand manipulandum was used with pointers aligned centrally and two targets on either side. For each trial a precue indicated the upcoming potential response. Five neurologically normal participants received two sessions (640 trials each), five precue conditions that included: hand known, extent known (HKEK), hand known, extent unknown (HKEU), hand unknown, extent known (HUEK), hand unknown, extent unknown (HUEU), and all unknown (ALLU—hand, extent unknown, and all 4 targets precued). A visual precue (500 ms) was followed by a variable foreperiod (1000, 1500, or 2000 ms) and an imperative stimulus that required movement of the correct pointer quickly and accurately to the appropriate target. RT was shortest for HKEK (245 ms) and longest for ALLU (318 ms). Within the three 2-choice conditions, HKEU (284 ms) was faster than HUEK (301 ms) or HUEU (300 ms). Left-hand RT was shorter than right-hand RT. Visual evoked potential latencies were consistent for stimulus presentation but were affected by precue presentation, possibly due to differences in luminance depending on whether one, two, or four

LEDs were lit. EEG measures indicated (1) hemispheric differences between contingent negative variation (CNV) amplitudes for right-hand responses (left hemisphere) but not for left-hand responses, and (2) larger CNV amplitudes when uncertainty was minimal. These associations are consistent with a cortical cell assembly mechanism for motor preparation.

### **Moving Beyond the Stigma: Self-Presentational Benefits of Exercise in Individuals With a Physical Disability**

Arbour, K.P., A.E. Latimer, M.E. Jung, and K.A. Martin Ginis. McMaster University

Individuals with a physical disability are often stigmatized (Miller & Cordova, 2002). Of concern, stigmatism can interfere with the acceptance of these individuals by their able-bodied peers (Fichten & Amsel, 1986). For people without a physical disability, presenting oneself as an exerciser has been identified as a strategy for creating a positive impression on others (Martin et al., 2000, 2002). The purpose of the present study was to determine whether this strategy is an effective means for managing the stigma encountered by individuals with a physical disability. In a  $2 \times 2 \times 3$  (Target's gender  $\times$  Rater's familiarity with disabled persons  $\times$  Target's exercise status) design, 393 participants read a description of a young man or woman with a physical disability who was described as an exerciser, nonexerciser, or control. Participants rated the target on 17 psychological and 9 physical dimensions. Separate MANOVAs revealed a significant main effect for target's exercise status on both the psychological and physical dimensions ( $p$ 's  $< .01$ ). Follow-up analyses indicated that exercisers received higher ratings than both nonexercisers and controls on 12 of 17 psychological dimensions and 6 of 9 physical dimensions. No other significant main effects or interactions were found. Overall, the results suggest that the self-presentational benefits associated with exercise may help undermine the negative stigma experienced by individuals with a physical disability.

### **Development of Psychological Characteristics in Elite Gymnasts: Evidence for Gender Differences**

Arripe-Longueville, F.<sup>1</sup>, C. Calmels<sup>2</sup>, O. Colonna<sup>1</sup>, M. Hars<sup>2</sup>, and N. Debois<sup>2</sup>.

<sup>1</sup>Université de Nice Sophia-Antipolis; <sup>2</sup>Institut National du Sport et de l'Éducation Physique

Based on talent development research across a variety of domains (Bloom, 1985; Csikszentmihalyi et al., 1993; Gould et al., 2002), this study examined psychological characteristics, their potential development in elite gymnasts, and possible gender differences in characteristic development. Ten elite gymnasts, 5 female and 5 male, were interviewed using an in-depth, open-ended, and semi-structured approach (Patton, 1987). For each stage of his or her career (i.e., sampling, specializing, and investment), each gymnast was invited to describe his/her specific training and competitive situations. The qualitative data were analyzed both inductively and deductively. Results revealed that the main common psychological characteristics perceived to be developed were: engagement, persistence, and self-confidence, which began to develop in the sampling years thanks to positive social influences; and the ability to cope with anxiety and pain, which developed in the investment years, through unpleasant social interactions and competitive experiences. Although all the participants developed their psychological characteristics through various methods, some gender differences were evident. Social influences were salient among females while the role of competitive experiences was predominant among males. Moreover, specific performance enhancement skills such as ability to focus, imagery, and self-regulation were suggested as developing earlier among males. Results are discussed in the context of previous talent-development literature and to the social theory of gender development and functioning (Bussey & Bandura, 1999).

### **Intra- and Intermodal Sensory Reweighting in Children's Postural Control**

Bair, W.-N., J. Jeka, and J.E. Clark. University of Maryland, College Park

The ever-changing sensory environment poses a significant challenge to postural control particularly in young children. Previously we reported preliminary results on children's postural responses to altered sensory conditions (Bair et al., 2003). In the present study we extend this work to both younger and older children for a more complete developmental characterization. Forty normally developing children ages 4 through 10 years were recruited to participate. Simultaneously oscillating touch (Tdrive) and visual stimuli (Vdrive) were presented to them as they stood quietly in a modified tandem stance. Tdrive (0.28 Hz) and Vdrive (0.2 Hz) oscillated in the mediolateral direction under 5 amplitude pair conditions (8:2, 4:2, 2:2, 2:4, and 2:8 mm for Tdrive and Vdrive, respectively) for 90 s. Head and center-of-mass mediolateral displacement were recorded for three trials in each amplitude condition. The ratio of the postural response amplitude to stimulus amplitude, i.e., gain, was used to measure the influence of the sensory input on postural sway while the temporal relationship was characterized by phase. Intramodal reweighting is the gain change when within-modality (e.g., touch) stimulus amplitudes vary while the alternate (e.g., vision) stimulus is held constant. Intermodal reweighting is the gain change when the within-modality stimulus is held constant while the alternate stimulus varies. The results suggest that postural displacement maintained a stable temporal relationship to the oscillating stimulus across conditions for all age groups. However, intramodal reweighting for both vision and touch develops gradually from 4 to 10 years of age for both head and center-of-mass displacement. There is little evidence of intermodal reweighting until the age of 10 when it begins to emerge. In summary, the results indicate that coupling within a modality develops before cross-coupling between modalities emerges. Cross-coupling between modalities suggests a more sophisticated internal model in which estimates of self-motion are generated from >1 source of information.

*Supported by NIH R01-HD042527*

### **Infant Stepping in the Presence and Absence of Optical Flow**

Barbu-Roth, M., A. Desprès, J. Provasi, D. Anderson\*, and F. Jouen. LPBD EPHE, Paris, France; \*San Francisco State University

Research has shown that many of a young infant's behaviors that were once considered hardwired are both modifiable and quite susceptible to contextual factors. Infant stepping is a classic example; it can be elicited in some contexts but not in others (e.g., Thelen et al., 2002), and it can be maintained and increased with training (e.g., Zelazo, 1983). In the current experiment, we attempted to determine whether terrestrial optical flow influenced the frequency of stepping. The number of steps taken by 24 infants 3 days old was recorded for 1 minute in each of four randomly presented conditions. In the first condition (Toward), infants were held upright above a rigid surface onto which was projected a checkerboard pattern of black and white squares that moved toward the infant. In the second condition (Static) the checkerboard pattern was static. In the third condition (Circular) a pattern of black and white triangles arranged in a pinwheel rotated clockwise on the surface. In the fourth condition (Natural) the static checkerboard pattern was used but the soles of the infant's feet contacted the support surface. A repeated-measures ANOVA revealed significant differences in the average number of steps taken per condition,  $F(3, 66) = 3.4$ ,  $p < .05$ . Follow-up simple main effects tests showed that significantly more steps were taken in the Toward condition than in the Static condition, in the Natural condition than the Circular condition, and in the Natural condition than the Static condition. These findings suggest that there is some degree of coupling between stepping and terrestrial lamellar optical flow at birth.

### **Gait Patterns in Adult and Elderly Individuals While Walking in Shallow Water and on Land**

Barela, A.M., and M. Duarte. UNESP, Sao Paulo, Brazil

This study examined the gait pattern of adult and elderly individuals while walking in two different environments, land and shallow water, to understand how they behave and adapt to such different conditions. Five healthy adults (ages 21–28 yrs) and 5 elderly individuals (65–77 yrs) participated in the study. We analyzed kinematic, ground reaction forces, and electromyographic activity during walking in both environments. We measured hip, knee, and ankle joint angles in the sagittal plane, body mean speed, and step length during a stride using a digital camera and a waterproof housing for a 2-D kinematic analysis. Vertical and horizontal ground reaction forces were measured with a waterproof force plate. Surface electromyography was collected from 8 muscles. Participants walked for 10 times in each condition (shallow water and land) at self-selected speeds on a 6-m walkway with a force plate flush in the middle of it. In the water, they walked with the water at the externum level which resulted in approx. 60% of reduction in apparent body weight for both groups. Walking speed was about 3.4 times slower for the younger adults and 3 times slower for the elderly individuals in water than on land. Younger adults walked faster than elderly on land, although they walked at the same speed in water. Step length was approx. 3% and 12% longer for younger adults than for elderly on land and in water, respectively. There were major differences in joint angles as well as in the ground reaction force patterns between land and water environments, although these differences were about the same for both groups. In summary, walking in water showed a different pattern vs. walking on land, but we did not observe differences between younger and older adults. We interpreted these results as an indication that the elderly were able to adapt to the different environment in a similar way as the younger adults did.

### **Physical Activity and Postural Control in Elderly: Coupling Between Visual Information and Body Sway**

Barela, J., P.B. Freitas Jr., and A.C. Prioli. UNESP, Sao Paulo, Brazil

Aging is characterized by a decline in postural control performance, which is based on a coherent and stable coupling between sensory information and motor action. Therefore, changes in postural control in elderly persons can be related to changes in this coupling. In addition, it has been observed that physical activity seems to improve postural control performance in elderly persons. These improvements can be due to changes in coupling between sensory information and motor action related to postural control. Thus the aim of this study was to examine the coupling between visual information and body sway in active and sedentary elderly persons. Sixteen sedentary, 16 active elderly persons, and 16 young adults stood upright inside a moving room that was moved in two ways: (a) continuous back and forward at a frequency of 0.2 Hz, displacement of 1.12 cm, and peak velocity of 0.69 cm/s for 60 sec; and (b) discrete, with the room being moved back or forward during 2 sec, with displacement of 2.6 cm and peak velocity of 1.3 cm/s. The room position and participant body sway were obtained through Optotrak IREDs. In the continuous condition, dependent variables were coherence, gain, relative phase, and angular deviation. In the discrete condition the dependent variable was anterior or posterior body displacement induced by the room movement. The results of the continuous condition showed that the coupling between moving room and body sway was stronger and more stable for both elderly groups compared to the young adult group. In the discrete condition, sedentary elderly persons showed larger body displacement than active elderly persons and young adults. The overall results showed that elderly persons are more influenced by the manipulation of sensory information, suggesting that they have difficulty discriminating sensory conflict

situations. This might be due to impoverished sensory integration; however, physical activity seems to diminish this impoverishment.

### **Human Performance Under Demanding Conditions: An Examination of Time Distortion in Elite Endurance Athletes Reporting Flow States**

Barnes, R. University of Florida

This study examined flow states and the perceived distortion of time. Five elite college distance runners were interviewed regarding an optimal running experience in which they were totally absorbed in the event and the experience was highly enjoyable or pleasing to them. Following the interview, they were asked to answer standardized questions pertaining to the perceived distortion of time. It was hypothesized that: (1) In regard to the perceived distortion of time, runners would report a speeding up, as opposed to a slowing down, of perceived time. (2) Verbal reports would indicate that runners viewed the time distortion phenomenon as an enjoyable experience that was beneficial to their performance. (3) Despite the perceived distortion of time, it was believed that transcripts from interviews and participant information questionnaires would indicate that time cues in the athletes' environment (e.g., time splits) were clear and attuned to while performing. (4) While being interviewed, a majority of athletes would select a flow state in which they experienced time distortion when competing or performing optimally, as opposed to training. (5) Athletes who chose a competitive run in which they had achieved a high level of performance would report a greater time distortion than athletes who recalled a flow experience in which they were not running competitively. The results suggested that the first four hypotheses were supported, while no comparisons were made on the final hypothesis. This was due to the fact that all participants chose a competitive experience to report on. Implications of the results and suggestions for future research are also offered.

### **Emotional Reactivity: Mapping Discrete Psychophysiological Responses Onto Movement Execution**

Barnes, R., S. Coombes, C. Janelle, and A. Duley. University of Florida

Emotions bias action and arise in situations requiring adaptive control (Ekman & Davidson, 1994). Little is known, however, concerning how emotions influence overt motor function associated with adaptive control. Speed and accuracy of a self-paced square tracing task were examined following exposure to 9 independent emotion-eliciting sequences of stimuli: (1) AD = adventure; (2) FA = family; (3) EN = erotic nudes; (4) EC = erotic couples; (5) MU = mutilations; (6) HA = human attack; (7) IN = insects; (8) SN = snakes; and (9) HHO = household objects. For each of 40 trials, participants ( $N = 39$ , 21 *M*) viewed 4 same-category pictures (2 sec each) for a total of 8 sec. At picture offset, a square tracing task was completed, with the degree of error and time taken to complete the task being the dependent measures of interest. Exposure to MU, HA, IN, and SN categories were predicted to decrease speed and increase error during subsequent motor performance. Times following exposure to EC were slower than for all other categories. Error was significantly less following AD, EC, EN, and FA categories when compared to SN, MU, IN, and HHO categories. Heart rate, skin conductance response, and self-report measures corroborated previous trends of arousal, valence, and dominance. In summary, accuracy of motor performance varies as a function of affective valence. Future studies may (a) decrease the number of stimuli per trial and increase intertrial intervals to maximize emotional impact on performance; (b) decouple similar motor performance characteristics following exposure to unpleasant and neutral categories; and (c) validate/confirm accuracy findings, while further investigating potential temporal components of the emotion/motor performance relationship.

### **Getting Children Physically Active: Opportunities and Mechanisms**

Battista, J., C. Nigg, J.A. Chang, M. Yamashita, and R. Chung. University of Hawaii

There are numerous benefits of regular physical activity during childhood. Despite this, approx. 9 million young people in the U.S. are overweight. Therefore it is important to identify physical activity opportunities and the mechanisms that are important for physical activity adoption in kids. This study looked at (a) the activity during after-school programs in 12 elementary schools and (b) the mediators across the stages of change for students in Grades 4–6. The System for Observing Fitness Instruction Time (SOFIT) was used to measure student activity levels and lesson context during the after-school programs, and a questionnaire assessed stage, attitude, enjoyment, intention, subjective norms, perceived behavioral control, and self-efficacy. Based on SOFIT, the students spent an average of 110 minutes standing, sitting, and lying down, but less than 17 minutes engaging in moderate and vigorous physical activity during the after-school program. Management was the main lesson context (96 minutes) compared with game play and fitness (24 min). A total of 533 students completed the survey (48.0% girls). In all, 75% of students participate in physical activity at least 5 d/wk for 30+ min. Questionnaire results revealed that the students participate in strenuous activity 3.89 d/wk ( $SD = 2.24$ ) and in moderate activity 3.12 d/wk ( $SD = 2.27$ ). Instrumental and affective attitudes, subjective norm, enjoyment, and intent to exercise increase significantly across stage,  $p < .05$ , with stage differences noted. These findings point to an opportunity to incorporate physical activity during after-school programs, which has the potential to teach lifelong health behavior skills. The mediators by stage-of-change results indicate that even for children, different variables are important at different stages of the physical activity adoption process, which has related implications for intervention.

*Funded by Hawaii Medical Service Assoc., an Independent Licensee of Blue Cross & Blue Shield*

### **Athletes' Perceptions of Coaching Behaviors and Multidimensional Role Ambiguity Within Team Sports**

Beauchamp, M.<sup>1</sup>, S. Bray<sup>2</sup>, M. Eys<sup>3</sup>, and A. Carron<sup>3</sup>. <sup>1</sup>University of Leeds; <sup>2</sup>University of Lethbridge; <sup>3</sup>University of Western Ontario

This study examined the relationships between coaching behaviors and athletes' perceptions of role ambiguity. Participants were 159 Canadian university athletes from a variety of interdependent team sports. Seventy-six athletes were male ( $M$  age = 21.14,  $SD = 2.01$ ) and 83 were female ( $M$  age = 20.55,  $SD = 1.78$ ). Early to midway through their respective seasons, athletes' perceptions of the degree to which coaches engaged in training and instruction and positive feedback behaviors (cf. Chelladurai & Saleh, 1980) were examined in relation to their experience of multidimensional role ambiguity (cf. Beauchamp et al., 2002). For non-starters, coaches' training and instruction behaviors accounted for significant variation in offensive and defensive role-consequences ambiguity as well as offensive role-evaluation ambiguity. However, for starters, neither of the coaching behaviors assessed in this study could explain significant variance in any of the role ambiguity dimensions. Results are discussed in terms of theory development and future research on possible antecedents of multidimensional role ambiguity.

### **An Exploratory Investigation of the Relationships Between Transformational, Developmental Exchange, and Corrective Avoidant Leadership and Exercise Participants' Self-Efficacy**

Beauchamp, M., A. Welch, and A. Hulley. University of Leeds

The purpose of this study was to examine the relationships between transformational, developmental exchange, and corrective avoidant leadership behaviors (cf. Bass &



Avolio, 2000) and the self-efficacy of participants involved in a structured 10-week exercise program. Three weeks into their exercise classes 174 women ( $M$  age = 25.36 yrs,  $SD$  = 8.48) provided ratings of their exercise instructor's various leadership behaviors as well as their personal efficacy related to scheduling, overcoming barriers, and within-class capabilities. Results revealed that for exercise initiates, developmental exchange leadership behaviors were able to explain unique variation in scheduling self-efficacy and barrier self-efficacy, but not within-class self-efficacy. For experienced exercisers, none of the leadership behaviors assessed in this study were associated with participant self-efficacy. Findings are discussed in terms of the application of Bass and Avolio's (1994) "full-range leadership" paradigm to future exercise leadership research and interventions.

### **Variability and Adaptive Process in a Coincident Timing Task Acquisition**

Benda, R., H. Ugrinowitsch, U. Corrêa, and G. Tani. Belo Horizonte, Brazil

Variability has been seen as noise in current theories of motor learning. Adaptive process understands the human being as an open system. In these systems, the formation of new structures requires instability. Variability is one factor of instability in the system. In the first experiment 20 undergraduate volunteers undertook extensive practice of a coincident timing task involving a sequence of movements, divided into two groups according to variability of relative timing (macro structure) in the last block of trials of stabilization phase: low (LVG) and high variability group (HVG). A one-way ANOVA (blocks) for absolute error showed significant differences only for LVG,  $F(35, 324) = 2.46, p < 0.0001$ , and Tukey's test indicated differences between the last block of trials of the stabilization phase and the first and second blocks of trials of the adaptation phase,  $p < 0.05$ . The sensibility of disturbance in LVG is discussed as indicative of system organization. Experiment 2 used the same procedures as the first study. However, the groups were divided according to variability of absolute timing (micro structure). A one-way ANOVA (blocks) for absolute error showed significant differences for LVG,  $F(35, 324) = 3.22, p < 0.001$ , and Tukey's test indicated difference between the last block of trials of the stabilization phase and the first and second blocks of trials of the adaptation phase,  $p < 0.05$ . It also observed significant differences for HVG,  $F(35, 324) = 3.06, p < 0.001$ , and Tukey's test indicated difference between the last block of trials of the stabilization phase and the first block of trials of the adaptation phase,  $p < 0.05$ . After disturbance, HVG returned to the level of the stabilization phase more rapidly than LVG, which suggests that high variability after performance stabilization is indicative of a flexible system. We conclude that only micro structure variability after performance can play a facilitative role in adaptation.

### **Center-of-Mass Movement and Energy Recovery During Walking in Children With Cerebral Palsy**

Bennett, B., A. Wolovick, T. Franklin, P. Allaire, and M. Abel. University of Virginia

There has been considerable interest in the movement of the center of mass (CoM) in walking as a collective variable of energy costs in both normal and pathological gait. It has been suggested that healthy walkers have movement strategies which limit the vertical excursion of the CoM and time its movement to allow for transfer between kinetic (KE) and potential energy (PE) to minimize energy consumption. Neither of these aspects of walking has been studied in children with cerebral palsy (CP). This research examined vertical CoM excursion, the phasic relationship between kinetic and potential energies of the CoM, and energy recovery at self-selected walking speeds. Kinematic data (3-D) were collected from 16 children with CP and 6 able-bodied children at three walking speeds (slow, typical, and fast). CoM position, its KE and PE, and the relative phase of the energies were computed. The energy recovery factor ( $R$ ) (Winter, 1990), the percentage of energy conserved via

transfer, was determined. The normalized vertical CoM excursion of children with CP was 70% greater,  $p < 0.03$ , than that of the controls. CoM excursion in the controls correlated with walking velocity,  $r = 0.62$ ,  $p < 0.01$ , whereas this was not true for children with CP. The relative phase of KE to PE in the control group was closer to the ideal of  $180^\circ$ ,  $p < 0.04$ . This phasic relationship suggests a less efficient movement strategy in children with CP, as reflected by the 30% smaller  $R$ ,  $p < 0.01$ . The results of this study show that both vertical excursion and relative phase can provide insights on walking efficiency. Further work is needed to quantify the relationships between these measures and energy consumption. Future work will include simultaneous measurement of  $\text{VO}_2$ , kinematics, and kinetics on an instrumented treadmill to allow a direct comparison of energy costs and these measures in children with CP with and without orthoses.

### **The Effects of Exercise Advertising on Exercise Self-Efficacy and Decisional Balance**

Berry, T. Wilfrid Laurier University

Although researchers have identified a number of reasons why individuals may exercise, the public sector uses health as the main exercise incentive while the private fitness industry focuses on appearance in their advertising. However, it remains to be determined what effect health and appearance-based exercise messages have on exercise-related cognitions. The purpose of this research was to determine whether televised health-promotion exercise advertising had a different effect than televised appearance-based exercise advertising on viewers' exercise self-efficacy and decisional balance (pros or cons of changing exercise behavior). Participants were 156 undergraduate students who viewed one of three 20-min videos containing neutral and exercise-related advertising, and a TV program that made no reference to exercise, sport, or appearance. The videos differed only in the treatment ads (health, appearance, or control) they included. This study used a Solomon design, so that 96 participants completed pretest and posttest questionnaires whereas 60 participants completed posttest questionnaires only. Data were analyzed using procedures outlined by Braver and Braver (1988) for Solomon design experiments. That is, ANOVAs were used to determine whether there were significant interactions between treatment conditions, gender, and pretest or no-pretest groups on the dependent variables. If there were no significant interactions, ANCOVAs were performed on the data from the group that included a pretest, with pretest scores and exercise stage as covariates. Results showed no pretest effects. Subsequent ANCOVAs showed that men in the appearance condition had significantly lower self-efficacy than women for exercising alone,  $F(2, 87) = 5.89$ ,  $p < .005$ ,  $\eta^2 = .12$ , or when there was resistance from others,  $F(2, 87) = 3.93$ ,  $p < .05$ ,  $\eta^2 = .08$ . Although further research is needed to confirm these results, it would seem that appearance is not a good exercise motivator for men, as it has a negative impact on exercise self-efficacy.

### **The Effect of Video as an Augmented Feedback Tool in the Acquisition of a Motor Skill**

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When performing motor skills, feedback about the characteristics and/or success of an action can come from many sources. From an internal perspective, proprioceptors in our muscles, tendons, and joints provide information about the position of our limbs in space. In addition to these built-in sources of feedback, information about performance can also come from external sources such as instructors or coaches, or more recently, from evaluating one's own performance on video replay. The present pilot experiment was designed to

explore the effectiveness of various sources of feedback in improving characteristics of the golf swing. Nine novice golfers (mean age 54.8 yrs; mean handicap = 32) underwent a pretest in which 10 swings were analyzed to determine average club face angle at the time of ball contact. The participants were then randomly assigned to one of three groups: (a) a verbal feedback group; (b) a verbal + video feedback group; or (c) a control group (no feedback). Following a 20-min feedback session and a 10-min rest, all groups were posttested to determine whether any improvement in club face angle had occurred. The results indicated that the group receiving verbal feedback showed the greatest amount of improvement. The control group also showed modest gains, although not to the same extent as the verbal group. However, the verbal + video group showed a drop in performance from pre- to posttest. These results suggest that simultaneously trying to integrate multiple sources of feedback hinders the learning process for novice performers.

### **On the Specialization of Visual Fields for the Preparation and Control of Reaching Movements**

Binsted, G., K. Brownell, T. Rolheiser, and M. Heath\*. University of Saskatchewan;  
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The dual-systems theory of human vision (Milner & Goodale, 1992) is predicated on the existence of two streams of visual processing extending through the extra-striate cortex: a ventral specialized for conscious perception of objects, and a dorsal pathway bearing information pertaining to guiding actions. Interestingly, the human lower visual field (VF) demonstrates a disproportionate number of projections to the dorsal regions (e.g., V6a, Previc, 1998). Accordingly, this asymmetry should introduce a processing advantage for "action" cues presented in the lower field, diminishing or nullifying Fitts' law (Danckert & Goodale 2001). The purpose of the current study was to examine the influence of these anatomical asymmetries on the preparation and execution of visually- and memory-guided reaching movements. Participants performed reaching movements to 4 targets with indices of difficulty ranging from 2.6 to 5.6 bits under 5 visual-memory conditions: full vision, and 0-, 2-, 5-, and 10-sec delay. Throughout all trials they were to maintain a fixation either above or below the presented target, resulting in movements being generated in the lower and upper VF, respectively. In accord with the dual systems theory, it was hypothesized that the introduction of visual delays should generate differential deterioration in movement performance due to the upper visual field's preferential connections with the ventral system (i.e., memory and perception). Moreover, the lower VF should demonstrate superior online control in the presence of vision due to its dorsal connection. The upper visual field should demonstrate a superiority in planning. Indeed, data supported the existence of a lower VF advantage for movement execution (MT); Fitts' law remained evident, however. A lower VF advantage was also apparent for movement preparation, and memory-driven reaching failed to differentiate visual fields. Results are discussed with regard to both the dual-streams theory of perception action and the planning-control model of action (Glover, 2003).

### **The Use of Virtual Reality for Training Balance in the Older Population**

Bisson, E., and Y. Lajoie. University of Ottawa

Using a computer program to train people and to rehabilitate patients is becoming more common in many domains. For balance impairment, virtual reality training has been used with stroke and TBI patients to rehabilitate balance. For the elderly population, computer-based biofeedback training has been shown to improve balance and reaction time, but virtual reality has never been experienced. The objective of this study was to determine whether virtual reality training could be effective in improving balance in older adults, therefore to prevent the risk of falling. Six healthy older adults (age 72.5 yrs  $\pm$  3.6) under-

went a 10-week training program in which they juggled with virtual balloons without moving their feet. They attended 30-minute sessions twice per week. Measures of postural sway and reaction time were taken and a functional test (CB&M) was monitored prior to the training program, and again a week and a month after the end of the program. After completing the program, older adults had significantly improved their score in the CB&M test and had faster reaction time. However, there was no difference in postural sway before and after the training program. Thus, the training was effective for improving balance by improving functional abilities and by minimizing the amount of attention needed for good balance. It is possible that older adults trained with virtual reality have greater attention to react to their environment, thus minimizing the chances of falling.

### **Internal Focus of Attention is Superior to External Focus When Training is Extended to Several Weeks**

Black, C. SUNY Brockport

Two experiments were conducted to examine the effect of attentional focus while performing a golf chip shot similar to that used by Wulf, Lauterbach, and Toole (1999). Experiment 1 replicated the findings of Wulf et al. Eighty practice trials were performed in a single practice session. Participants who focused attention on the action of the club (external focus) scored higher than those who focused attention on the arm action (internal focus) during both the practice session and the delayed retention test. Experiment 2 used the same task but practice was extended to 11 sessions of 30 trials each, for a total of 330 practice trials. No difference was found between internal and external focus during practice, but internal focus was superior to external focus on the delayed retention test. Many coaches focus learners' attention on their own actions in the belief that this will improve technique and eventually produce success (Warren, 1988). Experiment 2 supports this internally-focused approach for long-term training and contradicts recent studies using brief 1- or 2-day practice sessions that have found external focus to be more effective (Wulf, Hoess, & Prinz, 1998; Wulf, Lauterbach, & Toole, 1999; Wulf, McNevin, Fuchs, Ritter, & Toole, 2000; Wulf & Weigelt, 1997). Internal focus may be disruptive in the short term, but ultimately it will lead to better learning.

### **Athletic Identity, Perceived Control, and Burnout in Adolescent Swimmers**

Black, J.M., and A.L. Smith. Purdue University

Athlete burnout is a psychological syndrome of emotional/physical exhaustion, reduced sense of accomplishment, and sport devaluation (Raedeke, 1997). Theoretical perspectives on burnout emphasize physical and psychological stress as key antecedents of the phenomenon (Silva, 1990; Smith, 1986). However, Coakley (1992) argues that the structure of competitive sport is an important contributor as well because it has implications for identity development and control. Specifically, greater identity exclusivity and external control contribute to burnout. This study assessed the association of athletic identity exclusivity and perceived control with athlete burnout. It was hypothesized that higher swimming identity exclusivity and lower perceived control would predict higher burnout perceptions, over and above perceived stress and training volume. Senior-level swimmers ( $N = 182$ ), ages 13 to 22 years ( $M = 16.0$ ,  $SD = 1.6$ ), completed reliable and valid swimming-specific measures of athlete burnout, perceived stress, athletic identity (strength and exclusivity), and perceived control. Athlete training demands and swimming performance data were also obtained. Hierarchical multiple regression analyses were conducted on the respective burnout components, with performance entered on the first step as a covariate, perceived stress and training volume entered on the second step, and athletic identity and perceived control variables entered on the third step. The models predicted a meaningful

proportion of burnout variance ( $R^2 = .25$  to  $.49$ ). Perceived stress was the dominant predictor of athlete burnout, with swimming identity strength (not exclusivity) contributing additional explained variance in the global burnout, reduced sense of accomplishment, and devaluation models. Higher stress and lower swimming identity strength predicted higher burnout. The results did not support the hypothesized pattern of relationships, but they do suggest that continued examination of Coakley's perspective is warranted.

### **Using the Theory of Planned Behavior to Explain Exercise Behavior in a Community Sample of African Americans and Caucasians**

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The purpose of this study was to determine the utility of the theory of planned behavior (TPB) in explaining exercise behavior over a 2-week period in an African American (AA) and Caucasian community sample. A total of 427 participants (203 AA; 224 Caucasians) with a mean age of 42.11 ( $SD = 14.0$ ) were recruited through local YMCAs in Atlanta, Georgia. Upon recruitment, they completed a TPB questionnaire on attitudes, subjective norm (SN), perceived behavioral control (PBC), intention, and normative, behavioral, and control beliefs. Then they were asked to complete an exercise log book for a 2-week period, after which they returned it to the YMCA. Latent variable regression analyses using HLM 5.0 showed that SN and PBC were significant predictors of exercise intention in AA (SN beta =  $.10$ ,  $p < .05$ ; PBC beta =  $.40$ ,  $p < .01$ ) and Caucasians (SN beta =  $.16$ ,  $p < .02$ ; PBC beta =  $.55$ ,  $p < .01$ ). Furthermore, intention significantly predicted behavior in AA (beta =  $1.18$ ,  $p < .05$ ) and Caucasians (beta =  $2.13$ ,  $p < .01$ ). Finally, correlational analyses showed that reduced stress, support from family and friends, pain, and lack of time were key beliefs underlying the AA's attitudes, SN, and PBC, whereas improved energy, feel better, support from spouse, and family commitments were the key underlying beliefs for Caucasians. Therefore it appears that ethnic-specific beliefs may need to be targeted when developing future exercise interventions.

### **Temporal Pattern Modification and Proactive Interference in Relearning Motor Sequences**

Blischke, K., S. Brueckner\*, and P. Schindler. Saarland University; \*University of Tennessee Knoxville

In rehabilitation as well as in sports, people often are required to change performance of a highly overlearned motor skill. This need to "relearn" sometimes results in detrimental proactive interference, but sometimes relearning the skill in a different mode is facilitated by the previous learning experience. However, what exactly hampers or facilitates relearning is not well understood. We suppose that changes in movement structure—its temporal, spatial, and/or dynamical pattern—should result in proactive interference, while changes in movement parameters should render possible proactive facilitation. To test this supposition, we had a treatment group (TG) of participants practice a spatio-temporal pattern in a diamond tapping task (800 trials; KR provided on every second trial). Two days later the sequence was practiced again for another 800 trials, same procedure. This time, however, the temporal pattern (TP), i.e., proportion of intertap-intervals, was changed while total movement time (TMT) and spatial requirements were kept the same. Retention of this second version, the "criterion sequence," was tested 1 day and 3 days after practice (100 trials per test; no KR). Subjects were instructed to always match both target values (TP and TMT) specific to the criterion sequence. A control group (CG) practiced only the criterion sequence (800 trials with KR). With respect to the criterion sequence, the groups did not

differ in TP-performance during practice. However, TP scores of the TG went down during retention, while the CG maintained the TP performance level reached in the last block of practice trials (significant Group  $\times$  Block interaction). This result indicates a delayed proactive interference effect in the TG due to changes in (temporal) movement structure. There were no group differences in TMT performance in this study. In a previous study, proactive facilitation had been found when TMT (the temporal parameter) was changed, while the TP was kept the same. The structure/parameter distinction therefore promises to be a helpful tool for the analysis of relearning phenomena in the motor control domain.

### **An Investigation of Barriers to Physical Activity Among Women With Arthritis, Using an Ecological Approach**

Bloomquist, C.D., S. Hillard, N.C. Gyurcsik, T. Hacker, and R. Morales. Kansas State University

Arthritis is one of the most common chronic diseases in North America. Since there is no cure for arthritis, physical activity is one recommended strategy for managing the negative health impacts of this disease. However, people with arthritis are less physically active than people without arthritis, and 35% of people with arthritis are completely inactive. Therefore, the correlates of physical activity should be examined to guide future intervention strategies. Although barriers have been one of the most frequently examined correlates of physical activity in healthy populations, only limited research has looked at barriers in populations with arthritis. Thus the purpose of this study was to examine barriers to physical activity among women with arthritis. Women ages 21 years and older participated in one of four focus groups. They responded to open-ended questions that focused on the ecologically-based barrier categories of: intrapersonal, interpersonal, institutional, community, public policy, and physical environmental. Analyses of the transcribed focus-group data revealed that women with arthritis experienced barriers in each of the six ecologically-based categories. Some of these barriers were similar to those identified in past research with healthy populations, such as the intrapersonal barrier of insufficient time to engage in physical activity and the physical environmental barrier of a lack of sidewalks. However, other barriers were specific to individuals with arthritis, such as the intrapersonal barrier of pain due to arthritis and the interpersonal barrier of the lack of a physical activity support group composed of people with arthritis. Future research should identify salient barriers to physical activity among women with arthritis and develop ecologically-based interventions to aid in the eradication of such barriers as a way to promote regular physical activity and reduce the negative health impacts of arthritis.

### **Examining the Mediating Effects of Positive Team Sports Involvement on Risks for Depressive Symptoms in Adolescence**

Boone, E., and B. Leadbeater. University of Victoria

Social acceptance and body image are key risk factors for depressive symptoms among adolescents (Harter et al., 1992). Little is known about factors that can mediate these risks. Research linking sports involvement to depression has been contradictory, finding both risk and protective effects. To better understand how sports involvement may mediate risks for depressive symptoms, we need to look beyond levels of involvement and ask *how* the qualitative nature of team sports involvement operates to influence depression. **Methods.** Cross-sectional data were collected from 455 students in Grades 8 to 10 in a moderate-size Canadian city. A variety of well-validated self-report measures (e.g., Harter's [1988] Adolescent Self-Perception Profile) were used to assess adolescents' perceptions of social acceptance, body image, and depressive symptoms. Positive team sports involvement was assessed using a measure designed for the current study. Using a 5-point Likert scale, participants rated 20

items indicating how often positive and negative experiences occur when they are playing team sports (e.g., "My coach recognizes my efforts"; "My teammates make fun of me"). **Results.** Structural equation modeling showed that the mediating model,  $\chi^2 (97, N = 449) = 197.52, p < .001$ , CFI = .96, RMSEA = .05, fit significantly better than the direct effects model,  $\Delta\chi^2 (4, N = 449) = 344.808, p < .001$ . Gender differences in regression coefficients were not significant. **Conclusions.** Community- and school-based sports programs need to ensure that team sports environments offer adolescents the opportunity to build strong social networks, gain constructive feedback on skill development, and receive warm, supportive coaching in order to help diminish the risks for depressive symptoms.

### **Age-Related Changes in Lower Extremity Coordination While Walking Sloped Surfaces of Various Inclination**

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When a walking environment becomes challenging enough, oftentimes a phase shift to a new gait pattern may be observed. Gait changes in young adults have been observed for walking sloped surfaces (Earhart & Bastian, 2000; Sun et al., 1996). The purpose of this pilot study was to examine whether age-related adaptations in intralimb coordination occur when walking on a treadmill at different inclinations. One healthy older (age 72 yrs) and one healthy younger (22 yrs) adult walked on a treadmill at a self-selected pace for 7 conditions: level,  $\pm 5\%$ ,  $\pm 10\%$ , and  $\pm 15\%$  grades. Two-dimensional videography (Peak Performance Technologies, Inc., Englewood, CO) was used to determine left ankle and knee joint angles across three consecutive strides. The data were filtered and each stride was time-normalized. Ankle-knee angle plots of the stance phase were generated for each individual and condition. Results revealed different movement forms for age and condition. Qualitatively, the greatest change in intralimb coordination occurred when comparing walking on a level surface to walking uphill. A phase shift appeared to occur at different percent grades for the two age groups:  $+10\%$  grade for the older adult and  $+15\%$  grade for the younger adult. The nature of change also appeared to be different. Little to no ankle involvement was observed for the uphill conditions for the older adult. Freezing the ankle joint may be related to a lack of anterior tibialis strength. No distinct phase shifts were observed for the downhill conditions; however, age differences in strategy were apparent. The older adult had greater plantar flexion at heel strike for the downhill conditions than for the level condition. This may indicate a flat-footed landing used as a braking mechanism. Overall, greater adaptations may have been observed for the uphill condition than the downhill condition, due to greater energy demands to overcome gravity.

### **Walking Experience and Obstacle Avoidance in Infants**

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This study examined the step walking organization during obstacle avoidance in infants with different walking experience. Thirty infants were placed into one of three groups: 1, 3, or 6 months of walking experience. All infants walked in a runway in two experimental conditions: without and with obstacle. In the obstacle condition, a stripe of white foam 2 cm high and 3 cm wide was used to create the obstacle that infants had to step over. Markers were placed on the joint centers of both legs of the infant. Walking performances were videotaped in the sagittal plane for both sides simultaneously. Three cycles for normal walking, three for supportive leg, and three for approaching leg, in the obstacle condition, were digitized using the ARIEL system. Based on the digitized cycles, stride length, duration, velocity, and frequency were calculated. In addition, the horizontal and vertical distances from the infants' foot and the obstacle were calculated for both supportive and approaching legs. MANOVAs indicated that the 1-month-experienced infants walked with shorter stride

length compared to the 3- and 6-month-experienced infants, and slower than the 3-month-experienced infants. When infants had to step over the obstacle, they walked with shorter stride, slower velocity, and lower frequency than when they did not have to step over the obstacle. The horizontal distance from each infant's foot and the obstacle was larger in the approaching leg vs. the supportive leg, and similar among all three age groups. The vertical distance for both legs was similar in the 1-month-experienced group and increased for the 3-month-experienced group. And while this distance for the supportive leg was similar for the 6-month-experienced group, the vertical distance for the approaching leg significantly decreased. These results suggest that after some experience of walking, infants overshoot the leg lifting, but with more experience they improve their ability to use sensory information to step over an obstacle.

### **A Qualitative Inquiry Into Male Body Image Satisfaction**

Bottamini, G., and D.M. Ste-Marie. University of Ottawa

A growing body of research on male body image has revealed that similar to females, males also have concerns related to body shape and exhibit behaviors to attain or maintain their desired physique (Ricciardelli, McCabe, & Banfield, 2000). Most of the studies on male body image thus far have utilized quantitative methods, with few qualitative inquiries conducted. Recently Pope and colleagues (2000) noted the willingness of males to share their own body image concerns once its prevalence was revealed to them in conversation. Given the novelty of the research domain, a lack of qualitative methodologies, and the possible advantage of qualitative methods when exploring body image in males, the purpose of this study was to examine male body image satisfaction through a qualitative approach. Eleven males between the ages of 18 and 25 years ( $M = 21.18$ ,  $SD = 2.27$ ) who were from differing backgrounds participated in a semi-structured interview. They also verbally completed the Adult Figure Instrument (Collins, 1991) and the Male Figure Drawings (Lynch & Zellner, 1999). These scales served to examine the perceptions of the participants' current and desired physique and the body type they perceived that potential mates, friends, and the media viewed as ideal. Eight of the 11 participants expressed a desired change in body shape, with the majority identifying a mesomorphic body type as the preferred ideal of friends, potential mates, and the media. The data presented will also include two themes that emerged from inductive analysis: values/beliefs and feelings.

### **Evaluative Bias of Outgroup Team Members in Relation to Motivational Climate and Group Cohesion**

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The purpose of this study was to examine the outgroup bias (i.e., negative attitudes toward outgroup team members) in sport, and its relationship to perceptions of motivational climate and team cohesion. Male college basketball players ( $N = 86$ ) participating on 10 teams completed response measures including the Perceived Motivational Climate in Sport Questionnaire (Newton, Duda, & Yin, 2000) and the Group Environment Questionnaire (GEQ; Carron, Widmeyer, & Brawley, 1985). Players also provided ratings of outgroup (based on ethnicity), team members on interpersonal (i.e., friendliness, similarity), and task-related evaluations (i.e., competence, hard-working). Regression analysis revealed that favorable interpersonal evaluations were associated with favorable task-related evaluations of outgroup members on the team. Moreover, higher perceptions of a task-involving team climate were linked to both favorable interpersonal and task-related evaluations of outgroup members. Results also demonstrated that favorable interpersonal evaluations of outgroup members were associated with team cohesion. Finally, utilizing the four subscales within



the GEQ correlation indicated that attraction to group—social as well as group integration—social were related to favorable interpersonal evaluations of outgroup team members. Discussion highlights the functional nature of a task-involving team climate and group cohesion as potential approaches in an effort to reduce the outgroup bias in team sport.

### **Staying Active During First-Year University: Variable Effects of Transition on Vigorous and Moderate Physical Activity**

Bray, S., M. Kwan, and J. Millen. University of Lethbridge

Transition from high school to university is associated with a significant drop in vigorous activity (Bray & Born, 2004). However, regularly engaging in moderate intensity activities is also advocated as having important health benefits (ACSM; Pollock et al., 1998). This study investigated the effect of transition to university on both moderate and vigorous physical activity among first-year students. Consistent with U.S. behavioural surveillance data (Douglas et al., 1997; Kann et al., 1996), it was hypothesized that students' levels of both vigorous and moderate physical activity would decline from pretransition levels during the first year of university. We compared activity levels during the 8 months prior to transition to those during the first semester at university using the Godin Leisure Time Exercise Questionnaire. Participants were 157 first-year university students ( $n = 119$  females). As hypothesized, there was a significant decline,  $F(1, 156) = 6.31, p = .01$ , in average frequency of vigorous physical activity from pretransition ( $M = 4.56$  sessions/week) to university ( $M = 3.18$  sessions/week). Unexpectedly, however, no change,  $p > .10$ , was detected in average weekly moderate-intensity activity. According to USDHHS (2000) standards, 70% of students had been sufficiently vigorously active prior to transition, but the percentage had dropped to only 45% during first semester. For moderate intensity activity, 50% were active prior to transition and 46% during first semester. Results supported earlier findings of a decline in vigorous activity during transition, but showed less of an impact of transition on moderate intensity activity. Therefore, intervention efforts to promote healthy levels of physical activity among college/university students should focus on factors contributing to the decline in vigorous activity that occurs during transition and encourage more high school and university students to engage in moderate-intensity activities.

### **“There’s No Place Like Home”: Living at Home Eases the Negative Effect of Transition on Physical Activity During First-Year University**

Bray, S., J. Millen, and M. Kwan. University of Lethbridge

Transition from high school to college or university is a turbulent time involving ambiguity, change, and adjustment. Yet the academic transition itself may be relatively innocuous compared to the upheaval associated with relocating to a new social setting, residence, and community. For example, Lafreniere et al. (1997) showed that students who continued to live at home during transition experienced less disruption and stress than students who moved away from home. Bray and Born (2004) showed that transition to university is associated with a dramatic decline in physical activity. However, their analyses were restricted to students who had moved away from home to attend university. Given the buffering effect of maintaining residence at home on adjustment to first-year, we hypothesized that students who lived with their parents would remain more active through transition compared to students who moved away from home. Participants were first-year university students ( $N = 157$ ) who completed the Godin Leisure Time Exercise Questionnaire at both the beginning and end of their first semester at university. Chi-square analyses showed that changes in physical activity patterns were different for students living with their parents compared to those who were living on their own,  $\chi^2(N = 157) = 10.60, p < .05$ . Specifically, students who lived with their parents were more likely to maintain their current activ-

ity level (i.e., either staying active or inactive) and less likely to become insufficiently active during transition. Results suggest that previously active students who move away from home to attend university are vulnerable to adopting a sedentary lifestyle.

### **The Relative Effectiveness of Using Video and Point Light Demonstrations When Learning a Whole Body Coordination Pattern**

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The aims in this experiment were to determine the relative effectiveness of filmed and point-light display (PLD) demonstrations in the acquisition of intralimb coordination and to establish the importance of relative motion information during skill acquisition. Thirty-six novice adult participants were assigned to one of three groups and viewed either a filmed demonstration of a skilled cricket bowler (video), a PLD of the same action, or no demonstration (control). Participants were matched on ability based on the first 10 trials of practice when no demonstration was presented. During 60 acquisition trials, those in the PLD and video groups viewed the same demonstration five times prior to each 10-trial block. Retention was examined over 10 trials the following day. Intra-limb coordination was assessed using adjusted No-RMS procedures on the angular displacement of the right elbow relative to the wrist, in comparison to the model. If relative motion information is the critical constraining source of information for intralimb coordination, a PLD model was expected to facilitate acquisition compared to the video and control conditions. There was a main effect for acquisition,  $p < .01$ , but no interaction. All three groups improved as a function of practice. Orthogonal contrasts comparing across the three groups showed that the two demonstration groups performed more like the model than the control group,  $p < .01$ , but did not differ significantly from each other. These effects were maintained in retention. The results show that visual demonstrations are an effective tool for conveying intralimb coordination in cricket bowling. Although a PLD may potentially make relative motion information more salient, in this instance it did not offer any additional advantage to the learner above that offered by video demonstrations. Findings are discussed in the context of a constraints-led approach to skill acquisition.

### **Do Lesbians Face Unique Barriers to Physical Activity? An Ecological Examination**

Brittain, D.R., M. McElroy, N.C. Gyurcsik, C. Allen, and D.J. Aaron\*. Kansas State University; \*University of Pittsburgh

Participation in regular physical activity results in numerous health benefits, such as reduced risks for diabetes and cardiovascular disease. However, 78% of adult lesbians are not physically active at sufficient levels to achieve health benefits. Attention to barriers is critical to the understanding of why individuals might not engage in regular physical activity. Although individual-level barriers (e.g., income) and social environmental barriers (e.g., social support) have been found to limit participation in physical activity in healthy as well as diseased populations, no research has examined whether lesbians encounter barriers to participation in physical activity. The purpose of this study was to identify barriers to physical activity, both unique and similar to heterosexual populations, that adult lesbians may encounter. Four focus groups comprising 21 healthy self-identified lesbians ages 21–61 years, who were not currently moderately physically active, were conducted. The focus-group questions were based on six potential ecologically-based barrier categories of: intrapersonal, interpersonal, institutional, community, public policy, and physical environmental. Data analyses resulted in the identification of a number of individual-level and social environmental barriers found in prior research with other populations, such as a lack

of motivation (i.e., intrapersonal) and work-related (i.e., institutional) barriers. A number of barriers unique to the lesbian population were also identified, such as the policy-related barrier of fitness facilities not allowing lesbian partners to purchase family memberships. Future research should identify the most influential barriers to physical activity among adult lesbians and target the elimination of these barriers through ecologically-informed and innovative intervention strategies.

### **Planning and Control of Movements in the Upper and Lower Visual Fields: The Impact of Context**

Brownell, K., G. Binsted, and T. Rolheiser. University of Saskatchewan

Research has been accumulating over the last decade in support of the dual systems theory of human vision (Milner & Goodale, 1995) which proposes two streams of visual processing: a ventral system (visual perception) and a dorsal system (actions). Consistent with this view, visual context illusions are regularly demonstrated to generate perceptual judgment biases while permitting the unaffected production of motor responses (e.g., Haffenden & Goodale 1998). An interesting anatomical addendum to this perception-action hypothesis, however, is the preferential association between visual streams and visual fields. The upper visual field shows more projections to the ventral stream, while dorsal stream processing takes precedence in the lower visual field (Previc, 1998). The goal of the present study was to examine the impact of this asymmetrical representation on the preparation and execution of movements to illusory targets. Participants made 15-cm discrete pointing movements to targets (20, 30, or 40 mm in diameter) nested within Ebbinghaus/Tichener circles; this type of context illusion presentation has previously been demonstrated to induce movement production effects consistent with Fitts' law. In addition, participants were required to generate their reaching movements in either the upper or lower visual field either with full vision or 2 sec after removal of vision of the target. There are two conflicting hypotheses for these manipulations. Prior results from Danckert and Goodale (2001) suggest that Fitts' law should be moderated or eliminated for movements in the upper visual field. Conversely, the illusory context effects should be exaggerated in the upper visual field and when vision is removed, resulting in reaches consistent with the perceived target sizes. Interestingly, context effects are evident in both upper and lower visual fields. Specifically, both planning and control appear to be susceptible to perceptual/memorial influence, particularly during memory-driven reach (Westwood et al., 2000).

### **Examining the Effects of Group Characteristics on Energy Expenditure in Unstructured Exercise Settings**

Bruner, M., K. Spink, K. Wilson, D. Nickel, J. Watson, and J. Bostick. University of Saskatchewan

Physical activity behavior has been linked to group constructs, with the cohesion-adherence link receiving the most study (Spink & Carron, 1994; Watson et al., in press). While cohesion has received extensive attention, other salient characteristics of the group have received less attention. The purpose of this study was to examine whether other characteristics of a group as outlined by Carron and Hausenblas (1998) would be related to energy expenditure. Participants ( $N = 133$ ) in unstructured settings completed a modified MAQ (Krista et al., 1990) to assess physical activity, as well as a questionnaire used previously to assess group characteristics (Bruner et al., 2003). Discriminant function analysis was used wherein energy expenditure (low vs. high using a median split) served as the criterion variable and the characteristics of a group (e.g., enjoyment, common fate, norms and roles, communication and interaction, and self-identification), served as the predictors. A significant function resulted,  $\chi^2(3) = 11.92, p < .01$ , that had three factors: enjoyment,

norms and roles, and communication and interaction. The coefficients revealed that those in the high energy-expenditure group endorsed enjoyment and norms and roles in the group more than those in the low energy-expenditure group. Conversely, those who perceived communication and interaction to be high in the group were likely to be in the low energy-expenditure group. The findings provide initial support for the suggestion that specific characteristics of the group may be related to the energy expenditure of individual participants in unstructured exercise settings.

### **Temporal Desynchronization of Bimanual Reach-to-Grasp Movements in Children**

Bruyn, J., J-A. Lazarus, and A. Mason. University of Wisconsin

The current study examined the temporal coupling of the upper limbs in children performing bimanual movements. Previous studies by Jackson et al (1999; 2000) investigated bimanual coordination in adults and found that the upper limbs remained temporally synchronized during bimanual prehension regardless of whether the objects were equal or unequal in size. We examined whether this temporal synchronization of the upper limbs would occur in young children performing bimanual reach-to-grasp movements when the sizes of the objects were varied. Ten right-handed children, ages 4, 5, and 6 years, were instructed to simultaneously reach for and grasp large and/or small cylindrical objects with each hand. The size of the objects and their distance from the start position were scaled relative to each child's maximum finger span and maximum arm length, respectively. Reach-to-grasp movements were either congruent (both small or large) or incongruent (one small and one large). Results indicated that, similar to earlier experiments with adults, movement times were longest for the congruent small condition. However, for children in the current study, the hands were less synchronized during bimanual movements. Absolute difference scores were used to quantify between-hand timing differences at the start of the movement, at the end of the movement, at peak velocity, and at maximum grip aperture. No condition effects were found for the between-hand timing difference measures. More important, while the limbs were relatively coupled at the start of the movement (mean =  $80 \pm 15$  ms) and at the time of peak velocity (mean =  $75 \pm 10$  ms), they were less coupled at time of peak aperture (mean =  $190 \pm 35$  ms) and were decoupled at object contact (mean =  $250 \pm 50$  ms). This suggests that the need to obtain visual feedback during deceleration forces the child to attend to each hand separately, thereby reducing bimanual synchronization.

### **Manual Asymmetries Influence the Effector-Independent Transfer of Temporal and Spatial Variables in a Multijoint Limb Task**

Buchanan, J., Y-U. Ryu, and K. Zihlman. Texas A&M University

Learning and transfer as a function of handedness were studied in a single limb multijoint task. Participants practiced a  $90^\circ$  relative phase pattern between the elbow and wrist (flexion-extension sagittal plane) with a required amplitude ratio of 0.6 (wrist amplitude < than elbow amplitude). Wrist-elbow angle-angle plots based on the above task goals produce a vertically oriented ellipse. Participants practiced for 2 days, receiving concurrent feedback (24 trials) and terminal feedback (12 trials) each day. Eighteen right-handed individuals participated with 9 individuals practicing with the dominant (D) right arm and 9 with the nondominant (ND) left arm. With practice, both D and ND groups converged onto the required  $90^\circ$  relative phase pattern with  $\approx 10^\circ$  error between required and observed relative phase by the end of Day 2. A significant decrease in relative phase variability also occurred with practice, demonstrating that practice produced an attractor at the required  $90^\circ$  relative phase pattern. No differences were observed in mean relative or relative phase variability as a function of practice arm. However, the pathway to the required amplitude

ratio was distinct for each arm group. Individuals practicing with the D arm began with equal joint amplitudes and approached the 0.6 ratio by increasing elbow amplitude and holding wrist amplitude constant. Individuals practicing with the ND arm began with larger wrist than elbow amplitudes and approached the 0.6 ratio by decreasing wrist amplitude and increasing elbow amplitude from Day 1 to Day 2. Both groups transferred equally well the required relative phase pattern to one practice limb task and two nonpractice limb tasks. The ND arm group had significantly better transfer of the practiced amplitude ratio for all transfer conditions compared to the D arm group. The results demonstrate that relative phase was transferred across tasks in an effector-independent manner, whereas the effector-independent nature of the practiced amplitude ratio was dependent on arm dominance

### **The Influence of Physical Fitness on Cognitive Processing in Children Ages 7–11 Years**

Buck, S., C. Hillman, D. Castelli, H. Erwin, A. Son, and M. Bice. University of Illinois

Decreased efficiency of cognitive processing has been demonstrated in young children when compared to adult populations across a variety of stimulus-response tasks. However, participation in regular physical activity has been shown to have a significant positive impact on cognitive processing during childhood development, due potentially to physiological or learning/developmental mechanisms. Accordingly, this study examined the relationship between age and physical fitness on attention and working memory, which are critical components of cognitive processing. Behavioral (reaction time [RT], accuracy) and neuroelectric data (the P3 component of an event-related brain potential) were recorded from 28 children, some fit and some sedentary ( $M = 9.5$  yrs), and 35 adults, some fit and some sedentary ( $M = 19.5$  yrs) such that approximately an equal number of participants were placed in each of the four groups. Participants were shown a visual oddball paradigm with common (80% probability) and rare (20% probability) stimuli, and were instructed to press a button in response to rare stimuli while ignoring the common stimuli. Results indicated that P3 amplitude was greater for children compared to adults, and for fit compared to sedentary participants. Furthermore, age interacted with fitness, with larger P3 amplitude for fit children compared to the other three groups. Behavioral data corroborated the P3 findings, as adults and fit participants were faster and more accurate than children and sedentary participants, respectively. Also, age interacted with fitness for RT such that both adult groups were faster than both child groups; however, fit children were also faster than sedentary children. These findings provide an initial understanding of the potential beneficial effects of physical fitness on cognitive processing during childhood, and provide a basis for further study related to physical activity, developmental maturation, and cognition.

*Supported by UIUC Research Board Grant*

### **Perception-Action Cycle: A Developmental Study of Rope Jumping Performance**

Bueno, F.C.R., L.H. Silva, and A.M. Pellegrini. UNESP, Sao Paulo, Brazil

A key issue in rope jumping is the acquisition of relevant information to couple the jump with the rope trajectory. The present study was conducted to verify how children of different chronological ages and gender use sensory information in rope jumping. Six males and 6 females (ages 7–8 yrs; 11–12 yrs; and university students) performed sequences of rope jumping until they completed 20 successful jumps. Rope frequency and jump pattern were chosen by the participants. Performances were captured by a digital camera (120 Hz) for video analysis. In order to obtain data for the maximum vertical jump height (MVJH) and continuous relative phase (CRP), we fixed passive marks on the rope at the hip joint (greater trochanter) and ankle joint (lateral malleolus). CRP is  $\phi_{\text{Rope}} - \phi_{\text{Ankle}}$  at each se-

quence, with  $\phi_{\text{Rope}} = \tan^{-1}(\text{velocity/position})$ , according to Peter et al. (2003) and Kelso et al. (1986). MVJH were normalized to the greater trochanter height. ANOVA results showed higher mean CRP for the younger age group (199°) compared to the middle and older age groups (175° and 171°, respectively),  $F(2, 30) = 3.86, p < .05$ . In relation to MVJH, the mean of the oldest participants (18.2 cm) was higher than that of the 7- to 8-year-olds (14.1 cm), but there was no difference between the means of the two younger age groups (14.1 and 13 cm),  $F(2, 30) = 8.91, p < .01$ . In terms of MVJH stability, the results indicated that the youngest age group *SD* was higher (1.7 cm) than the others, and they did not differ between themselves (1.3 and 1.2 cm respectively),  $F(2, 30) = 8.52, p < .01$ . Results indicated no differences in gender, but there were developmental changes across age groups in the perception-action cycle for successful rope jumping performance.

### **Dribbling Improves Dribbling: Can You Expect Transfer Effects of a Hand-Ball-Coordinative Training?**

Buesch, D. University of Bremen, Germany

When practicing training with a focus on hand-ball coordinative skills, in the German-speaking community it is expected that in addition to well-trained movement skills, coordinative skills will also be improved. This widespread idea leads to the assumption that with the help of a respective training of coordinative skills, movement skills concerning ball handling will also be improved. This thesis has been examined in two quasi-experimental designs. A total of 35 pupils practiced a dribbling course in a period of 5 to 6 weeks, taking 15 minutes each week. The results of the training with its different requirements of the movement skill “dribbling” proved the expected effects concerning the movement-specific training, namely a statistically and practically significant improvement of dribbling skills. The results support the assumption of a near task transfer. Skill comprehensive effects by ball-coordinative training, which could make a further task transfer apparent, have not been proven. The results concerning the relevance of a systematic coordinative training in early and late childhood question the often postulated and widespread unspecific mode of action.

### **The Effectiveness of Different Types of Interventions Used to Promote Exercise Adherence: A Meta-Analysis**

Burke, S.M., A.V. Carron, M.A. Eys, and P.A. Estabrooks\*. University of Western Ontario; \*Kaiser Permanente–Colorado

The primary purpose of this study was to conduct a meta-analytic summary of the relative merits of three interventions used to promote exercise adherence: home- and/or individual-based programs; programs carried out in standard exercise classes; and programs carried out in exercise classes wherein group-dynamics principles were used to increase the class' sense of group unity (i.e., true groups). Standard literature searches produced 13 relevant studies that examined the effect(s) of one or more physical activity interventions on exercise adherence. Using these studies, a total of 52 effect sizes were obtained. Results showed that exercising in a true group had a large positive effect on exercise adherence (effect size [ES] = 1.09), while a moderate effect (ES = .40) was found for studies involving standard exercise classes (i.e., “collectives”). When comparing the effects of the interventions on adherence, a large effect size was found for exercising in a true group vs. exercising alone (ES = .61). In addition, a moderate positive effect was found in studies that utilized a true group vs. studies that utilized a standard exercise class (ES = .48). Finally, a small negative effect was found when comparing home-based programs (with contact from others) with standard exercise classes (ES = -.15); that is, exercising at home with contact was shown to be superior to participating in a standard exercise class in terms of adherence to

the exercise program. Results are discussed in terms of their relationship to group dynamics and exercise adherence.

### **Developmental Changes in Temporal Patterns During Supported Walking in Infants**

Buzzi, U.H.<sup>1</sup>, A. Ledebt<sup>2</sup>, and G.J. Savelsbergh<sup>3</sup>. <sup>1</sup>University of Michigan; <sup>2</sup>Vrije University Amsterdam; <sup>3</sup>Manchester Metropolitan University

Supported walking (cruising) is an important transition from quadrupedal to bipedal locomotion that is typically acquired after crawling. For the infant, it is the first attempt to move in an upright posture, which challenges equilibrium and requires a new coordination between hands and feet. As such, longitudinal changes in coordination patterns between the hands and feet may indicate improvements in locomotor skill during supported walking acquired with experience. In this study we looked at the temporal coordination patterns of 4 typically developing infants at an average of 9, 7, 5, and 2 weeks before the onset of independent walking (IW). Relative time of heel contact of the trailing leg and of hand contact of the ipsilateral (IL) and contralateral (CL) hands as a percentage of the gait cycle of the leading leg were calculated and plotted to observe temporal coordination patterns as a function of locomotor experience. Preliminary data showed that the trailing leg remained fairly consistent with an average ground contact time of  $52.9 \pm 1.67\%$  across experience levels and a decrease in intersubject variability with increased experience. Contralateral and ipsilateral hands showed a more varied pattern relative to the trailing leg initially with a shift toward a more stable pattern with experience. Overall, the coordination pattern between the arms and legs shifted from a synchronous hand pattern at 9 weeks before IW (IL hand hit = 35.75%, CL hand hit = 37.84%, CL leg hit = 54.99%) to an alternating pattern of CL hand (30.09%), IL hand (39.70%), and CL leg (52.92%). This suggests that with cruising experience the capacity increased to generate a more differentiated locomotor pattern, possibly relying less on the hands for support and more for guidance and facilitation of movement during supported walking.

### **Effects of Past Sports Injuries on Pain Threshold, Pain Perception, and Willingness to Compete During Injury**

Canter, R.J., B. Grayhem, S. Lilley, I. Wilson, and B. Raudenbush. Wheeling Jesuit University

Pain and injury are often a consequence of sports play. In addition, the likelihood of experiencing pain and injury increases as physical contact among athletes increases. Research has shown that previous experience with pain has a desensitizing effect on pain threshold and tolerance. Such a desensitizing effect is also more prevalent among contact sports athletes than noncontact sports athletes. The present study assessed athletes' recent injuries, the amount of pain associated with the injuries, and the amount of pain it would take to stop the athlete from practicing and competing. Based on past research, athletes participating in contact sports rated their pain as less severe and had a greater pain tolerance than noncontact sports athletes. Physical and temporal demand, and level of frustration, were lower for high-contact sports. Level of aggressiveness was greater in the high-contact sports; however, an analysis of covariance using aggressiveness as the covariate did not alter the outcomes of the pain threshold and tolerance measures. These results provide support for the role of physical contact on desensitizing athletes to pain. There is a significant difference between the amount of pain required to stop practicing and the amount of pain required to stop playing. Athletes are more willing to compete while injured and in pain, thus potentially compounding and worsening their injuries. Such results indicate a need for additional intervention and education concerning adequate injury healing time.

### **Hand-Eye Coordination in Simulated Laparoscopic Surgery**

Cao, C. Tufts University

The spatial arrangement of the endoscopic camera with respect to the surgeon and patient in laparoscopic surgery often requires surgeons to adapt to variable visuomotor mappings. This affects the perception of position and orientation of organs and tissues, and consequently the accuracy of manipulation and success of the surgery. The purpose of this study was to examine the role of hand-eye coordination, and the effects of misaligned endoscopic viewing perspectives on performance, during simulated laparoscopic surgery. A task space consisting of 5 vertical pins of various heights was placed in a laparoscopic trainer box with a rigid endoscope and laparoscopic graspers. The endoscopic image of the task space was projected onto a TV monitor. Based on this image, participants were directed to point and touch each pin in turn, using the laparoscopic graspers. The viewing conditions were varied by positioning the endoscope at 0,  $\pm 45^\circ$ ,  $\pm 90^\circ$ , and  $180^\circ$  with respect to the task space, and by rotating the endoscope along its long axis at 0,  $\pm 45^\circ$ , and  $\pm 90^\circ$ . Thirty individuals participated in the study. It was found that, regardless of the camera's position with respect to the task space, performance was affected only by the orientation of the endoscopic image of the task space. Participants had longer performance times when the image was inverted than when it was aligned to the natural viewing perspective. The task presented the least difficulty when the image was rotated by 0 or  $180^\circ$ , and the most difficulty when the image was at  $\pm 90^\circ$  or  $\pm 45^\circ$ . This seems to suggest that hand-eye coordination is achieved by mapping the hand space directly to the display space, without going through the intermediate transformations imposed by the physical arrangements of the camera position and orientation. This research has important implications for the design of imaging systems and tools in laparoscopic surgery, as well as for the training of visuomotor coordination in remote manipulation.

### **Variability in Muscle Activation and Force Direction in Two-Joint Isometric Actions**

Carlton, L., and D. Vandermeulen. University of Illinois

Increases in the level of force produced are associated with decreases in the consistency of force production for isometric actions. The form of the relationship between the level of force produced and variability in force is nonlinear and similar for both upper and lower extremities. The present study examined variability in muscle activation in a two-joint leg extension task. Two-joint tasks allow for variability in direction as well as force level. Of particular interest was whether the level of muscle activation between muscles was independent or correlated. Participants produced discrete isometric forces in a leg extension task from a fixed reclined sitting position. Goal forces were 50, 150, 350, 550, and 650 N, and time to peak force was 200 msec. Participants completed 80 trials at each force level and the last 50 trials were analyzed. Force level and direction, as well as peak and average EMG activity of the quadriceps and hamstrings, were measured. While force variability increased nonlinearly with increases in force, both peak and average EMG activity increased linearly. Quadriceps and hamstrings EMG activity were positively correlated at each force level, and force direction variability did not increase with force level. These findings suggest that muscle activation levels are linked so that the accuracy of force direction is preserved across force levels.



### **The Effect of Group Counseling on the Cohesion of a Women's College Soccer Team**

Carnicom, S., and T. Davis. Marymount University

This study examined the effect of group counseling on the cohesion levels of 22 women (ages 18–22) participating on an NCAA Division III college soccer team. Support through group counseling activities that focus on developing common goals, sharing thoughts and feelings, and addressing issues and concerns has been shown to improve group dynamics in therapeutic settings (Jacobs, Masson, & Harvill, 2002), but has not been applied to improving cohesion in an athletic team. In the present study a variety of techniques including Wubbolding's (2000) WDEP model in Reality Therapy and group behavioral interventions were used to foster group commitment toward achieving team goals. Team cohesion, measured using the Group Environmental Questionnaire (Carron, Brawley, & Widmeyer, 2002), was assessed at the beginning, middle, and end of the Fall 2003 sports season. A repeated-measures ANOVA revealed no significant changes in any of the four GEQ subscores of the soccer team across time. Furthermore, a mixed ANOVA revealed no significant differences between any of the GEQ subscores of participants on the soccer team and a control group that did not undergo the treatment (women's volleyball team,  $n = 12$ ). When compared with normative data for women's teams, the soccer team demonstrated statistically similar GEQ scores for all four subscales at the beginning of the season. However, by the end of the season they demonstrated significantly higher ATG-S ( $z = 2.36, p < .01$ ) and GI-S ( $z = 2.28, p < .05$ ) subscores. The control group demonstrated significantly higher ATG-S ( $z = 2.95, p < .01$ ), GI-S ( $z = 2.26, p < .05$ ), and GI-T ( $z = 1.65, p < .05$ ) subscores at the beginning of the study. However, by the end of the study only GI-S remained significantly higher than national norms for the control group,  $z = 2.23, p < .05$ . These results hint that group counseling interventions may be somewhat effective at maintaining if not improving participants' perceptions of group social interaction (ATG-S), but further research is needed.

### **The Effectiveness of Video Situational Awareness Learning in Response to Video Tennis Match Situations**

Caserta, R.J., and R.N. Singer. University of Florida

This study examined the effectiveness of specially designed, interactive video instructions on specific tennis-match-play training on situation awareness (SA), anticipation (A), and decision-making (DM). Response speed and accuracy measures were taken in videotaped match-play tennis situations and the effects on these behaviors were recorded in a primary tennis situation as well as two related tennis conditions. Novice/intermediate tennis players ( $N = 73$ ,  $M = 22.14$  years of age,  $SD = 6.20$ ) were randomly assigned to one of five groups: (1) tennis-specific SA and A training; (2) general SA and A training; (3) tennis-specific SA, A, and DM training; (4) general SA, A, and DM training; and (5) control. After receiving videotaped instructions, participants responded to a series of edited NCAA women's tennis match digital video clips. They reacted to the filmed opponent's shot selection and anticipated their movement to a location on the court. Video clips included two singles conditions, the first requiring a decision about where the player should move to be in a good position to receive the next shot and return it. The second condition required a decision as to where the player would hit the shot. In the third condition (doubles play) they had to decide where a particular player would hit the shot. A  $5 \times 3 \times 3$  (Groups  $\times$  Condition  $\times$  Shot Type) repeated-measures MANOVA and follow-up ANOVAs were conducted to determine if the participants in the five groups differed in each condition as well as response to shot types. Findings indicated that video instructions were effective for those groups trained with general SA and A strategies for both singles conditions vs. the doubles condition. Additionally, participants had faster DM times and accuracy scores when

viewing approach shots and volleys in the two singles conditions. The data lend support for using videotaped cognitive strategy training for behaviors of interest in this study, and players might find this game approach enjoyable and educational.

### **Motor Recovery Progress During Chronic Stroke: Hand Aiming Improvements**

Cauraugh, J.H., S.B. Kim, and A. Duley. University of Florida

Evidence supports the notion of motor recovery improvements when rehabilitating bilateral coordination movements coupled with active neuromuscular stimulation. The present study examined the effect of coupled bilateral coordination training and active stimulation on the motor capabilities of hand aiming movements. Twenty-six individuals in recovery from chronic stroke were randomly assigned to one of three groups: (a) coupled bilateral coordination and active stimulation; (b) unilateral movement and active stimulation; or (c) control group (no movement assistance). Separate mixed-design ANOVAs revealed Group  $\times$  Test Session interaction differences for movement time, peak velocity, and time to peak velocity. Participants in the coupled protocols group improved across test sessions more than did the other two protocol groups. Discussion focuses on the benefits of multiple behavioral interventions for motor recovery progress in hand aiming movements.

### **The Age-Related Difference in Length Perception by Free Wielding**

Chang, C-h.<sup>1</sup>, and M.G. Wade<sup>2</sup>. <sup>1</sup>Taipei City, Taiwan; <sup>2</sup>University of Minnesota

Previous study has shown that older adults tend to perceive shorter than young adults in length perception (Claudia, Thuot, & Turvey, 2000). The decline in muscular strength may be one reason for the difference. This study was designed to examine the effect of age and muscular strength on length perception of freely wielded rods. Participants were 7 undergraduates (age  $24.4 \pm 3.9$  yrs) and 7 older adults ( $67.7 \pm 2.9$  yrs). Each participant performed 30 trials in random order (5 length  $\times$  6 trials) without prior practice trials or feedback from experimenters. A 2 (age)  $\times$  5 (rod length) analysis of covariance on perceived length indicated that length perception was significantly different among rods and age groups,  $F(4, 59) = 109.91, p < 0.1$ ; and  $F(1, 59) = 14.17, p < 0.1$ , respectively. Participants were able to distinguish different rods without the benefit of vision, and young adults perceived differently than older adults. In terms of reliability of perception, a 2 (age)  $\times$  5 (rod length) ANCOVA showed that older adults were as reliable as young adults  $F(1, 59) = 2.73, p > 0.1$ , and perceived length was close to  $1/3$  of  $I_L$ . After ruling out muscular strength, older adults were as reliable as young adults in length perception; however, the difference in perceived length still exists.

### **The Kinematic Relationship Between Kicking and Stepping in Infancy**

Chang, C-L., and R. Angulo-Barroso. University of Michigan

Kicking and stepping are prevalent leg movements before independent locomotion emerges. Thelen and colleagues (1983) found that the spatio-temporal patterns of infant kicking were similar to mature walking. Infant treadmill steps have many kinematic similarities to adult walking (Ulrich, Jensen, Thelen, Schneider, & Zernicke, 1994). It has been proposed that the independent walking pattern may develop from the infant stereotyped movements such as kicking and stepping. However, the relationship between kicking and stepping in infants still remains to be investigated. The objectives of this study were (1) to examine the frequency relationship between kicking and stepping, and (2) to compare the kinematic patterns of kicking and stepping in infants from 4 to 7 months of age. Kicking and treadmill stepping movements of 8 normally developing full-term infants, 4 boys and 4

girls, were compared at 4, 5, 6, and 7 months of age. Each testing session included two conditions: kicking and treadmill stepping. All conditions were simultaneously videotaped and monitored bilaterally by four goniometers placed at the hips and knees. Each dependent variable, frequency, range of motion, and timing of angle reversals, was analyzed via repeated-measures ANOVA. Frequency of kicking and stepping was analyzed via Pearson correlation. The results suggested that (a) infants who kicked at high frequency stepped at high frequency (e.g., at 5 months,  $r = 0.84$ ,  $p = 0.009$ ; at 7 months,  $r = 0.85$ ,  $p = 0.014$ ), and (b) kicking and stepping showed many similar kinematic patterns. The findings of this longitudinal study provide a foundation for understanding motor development in leg movements and may be valuable for future researchers and clinical specialists to explore methods for improving the leg movements in infants with motor delays before independent walking.

### **Can EEG Discriminate Good and Poor Dart Throw Performance?**

Chang, C-W., J-H. Lin, S-C. Lin, Y-J. Chen, and T-M. Hung. Taipei, Taiwan

The purpose of this study was to examine the cortical activity underlying the EEG signal between good and poor dart throw. Fourteen male elite dart throwers were recruited to perform 60 dart throws that were grouped into 5 blocks, 12 darts each, on a standardized dart throw task. Good performance in this study is that the trials which represent the center-of-mass dart throw score higher than the mean, while poor performance includes those trials with unusually low scores. EEG was recorded at 13 electrode sites: Fz, F3, F4, Cz, C3, C4, T3, T4, Fz, F3, F4, O1, and O2. Eye movements were monitored using two bipolar arranged channels. In addition, two EMG electrodes were measured at a site one-third of the distance between wrist and shoulder to mark the onset of the throwing movement. The recorded EEG was segmented into four 0.5-sec epochs of the last 2 sec prior to the initiation of movement. Cleaned EEG epoch were fast-Fourier-transformed into three frequency bands:  $\alpha$ (9–12 Hz),  $\beta$ 1(13–20 Hz),  $\beta$ 2(21–30 Hz), and submitted to  $2 \times 4 \times 13$  (Performance  $\times$  Time  $\times$  Sites) ANOVA with repeated measures on all three factor separately. Although no significant performance effect were found in  $\alpha$  and  $\beta$ 2 power between good and poor performance, a significant performance effect was found in  $\beta$ 1. Specifically, the  $\beta$ 1 power of good performance was significantly lower than that of poor performance. The higher  $\beta$ 1 power prior to poor performance represented more cortical activation during preparation. Whether the heightened cortical activity as indicated by higher  $\beta$ 1 power before dart throw interferes with the nature of automatic processing of skill performance requires further study. A psychophysiological approach supplement with subjective information is recommended for future research into the mind of optimal performance.

### **The Effect of Local Muscular Fatigue on Cognitive Performance: An Event-Related Potential Study**

Chang, Y-K., J-H. Lin, J-F. Kao, C-L. Hung, L-C. Lo, and T-M. Hung. Taipei, Taiwan

Fatigue is an important topic in both exercise physiology and sport training. It has often been hypothesized to underlie the negative influence of strenuous exercise on performance and cognition. However, the finding that strenuous exercise had a negative effect on performance and cognition is not unequivocal. This inconsistency could be attributed to several factors such as type of fatigue, intensity of fatigue, complexity of task, and dependent measures used to evaluate the effects of fatigue. As such, the purpose of this study was, first, to examine how local muscular fatigue affects central information processing. Specifically, event-related potentials N100, N200, P300, reaction time, and premotor time were used to measure stages of information flow. The second purpose was to examine how complexity of cognition tasks moderates the effect of fatigue on central information processing. Twenty college students were randomly assigned to moderate and high intensity groups

with 10 participants each. A  $2 \times 2$  (Condition  $\times$  Task) two-way ANOVA was employed on each group separately. Findings were as follows: (1) Intensity of fatigue affects information processing differently. Moderate intensity of fatigue enhanced cognitive performance. This enhancement effect might be mediated by a heightened arousal. On the other hand, although higher intensity of fatigue negatively affects the speed of peripheral reactivity, it has a positive effect on the central processes. These findings suggest a central compensatory mechanism was called to prevent further deterioration of behavioral reactivity to the environmental demand. (2) Stroop task demands more processing resources than a discriminative task. (3) Both Stroop and discriminative tasks were affected by arousal; however, the central compensatory mechanism operates only on Stroop task. In conclusion, the central compensatory mechanism should include at least three aspects of information processing: (a) the attention resource employed to the stimulus; (b) automatic discrimination employed to the stimulus; (c) and cognitive evaluation of the stimulus.

### **The Attention Demands of Reaction Times Under Different Tempos of Dual Task for DanceSportmen**

Chao, C-L., and S. Liu. National Chung Cheng University, Taiwan

The purpose of this study was to examine reaction times under different levels of attention disturbance of dual task for DanceSportmen. Participants were 14 male and 16 female DanceSportmen,  $21 \pm 2.8$  years of age. They took the reaction time test for two tempos: 3 slow-beat and 3 fast-beat tempos. The Takei Model 1296-21C whole-body reaction measurement system was used. Repeated measures and LSD post hoc test were used to analyze the data. Results revealed the following: (1) The average of simple reaction time for all was  $9.7 \pm 5.1$  ms. The reaction time for 3-beat slow tempo was  $12.9 \pm 4.6$  ms and that for the 3-beat fast tempo was  $11.0 \pm 3.9$  ms. (2) There was a significant difference between simple reaction time for all ( $432.7 \pm 78.9$  ms) and 3-beat slow tempo ( $553.5 \pm 111.0$  ms). (3) There was a significant difference between 3-beat fast tempo ( $518.5 \pm 89.1$ ) and 3-beat slow tempo ( $553.5 \pm 111.0$ ms). Conclusions: (1) The simple reaction time was shorter under a normal situation without any attention disturbance. (2). The reaction time was shorter under the fast tempo than the slow tempo. (3) The speed of tempo may affect the DanceSportmen's psychological status and the function of the neuromotor system.

### **Impact of Training on the Acquisition of Pedaling Skills by Children**

Chao, P., and J.L. Jensen. University of Texas at Austin

The two broad modifiers of motor skill changes are maturational factors and experience. Thus, age-related changes in performance are often the product of both modifiers. This study tested the hypothesis that age (as representative of maturation) is positively correlated with motor performance only when experience is low. Nine children ages 4–10 yrs participated in this training study. To limit the effects from physical growth, the training protocol was conducted over a short period of 3 weeks. Performance on a pedaling task across 5 cadences (40, 60, 80, 100, and 120 rpm) was tested before and after three training sessions. Previously we have found clear age-related differences in the ability of children to perform across a range of cadences (Chao, Rabago, Korff, & Jensen, 2002). The older children were able to attain target cadences more accurately (Success Rate [SR] – ability to match) and consistently (Sustained Score [SS] – ability to maintain) compared to the younger children. In the present study we proposed to modify this age-associated improvement through training. The results showed significant improvement in both SR and SS after training,  $p < .05$ . The positive Age  $\times$  Performance correlation was significant before training,  $r > .7$ , but nonsignificant after training,  $r < .7$ . These findings support the hypothesis that for this age range, experience is a strong modifier of performance. The implications of this work lie in

identifying periods of developmental readiness whereby children's performance is susceptible to intervention by training.

*Supported by National Science Foundation under Grant No. 9986221*

### **Change of Degrees of Freedom in Whole-Body Movement Coordination**

Chen, H-H., Y-T. Liu, M-K. Gottfried, and K.M. Newell\*. Taipei, Taiwan; \*The Pennsylvania State University

This study examined the change of degrees of freedom during learning of a whole-body coordination task. Principal component analysis was conducted to analyze the process of learning the pedalo task. Haken's (1996) claim that using a single component for describing a complex movement pattern was tested. Whereas Haken et al. worked with joint angles of a 2-D projection, we analyzed data from a moving frame of reference in fully 3-D positions of 15 markers. The change of the number of components and the coefficients between observed variables and components was examined. In addition, the validity of using the Cauchy criterion to investigate the process of learning the pedalo task was tested by comparing the results of principal component analysis and the consistency of movement pattern. The result showed there was an increase in the percentage of variance accounted for by the largest component (~50% to ~80%) and a decrease from five to four components required to account for 90% of the variance of data over practice. Analysis of the coefficients of the principle components showed that after practice, the segments accounting for each component were changed in a consistent trend with the movement pattern. However, the data clearly show that more than one component is required to capture the movement variance in this task with the level of practice given, and that the Cauchy convergence criterion is useful for determining the learning of a movement pattern. We also could confirm that the variability of balance-relevant data (e.g., head position) significantly decreased with practice time.

### **Development of Unperturbed Sitting Posture: Influences of Touch**

Chen, L-C., J. Metcalfe, and J. Clark. University of Maryland, College Park

Previous work has shown touch influences on standing posture in adults and infants. Little is known, however, about whether infants use touch to stabilize their posture as they learn to sit. The purpose of this study was to characterize infants' sitting posture longitudinally and to examine how it is influenced by touch. Six infants were examined from the age when the infant was able to sit on a saddle-shaped chair (~2~3 months prewalk onset) until 9 months of walking experience. Infants performed three 60-s trials while sitting either independently (no touch) or touching a stationary surface. Six adults were tested on an analogous seat that was scaled to their larger body size. Sway excursions were assessed with variance-based measures including amplitude, variability, area, and velocity. Mixed-model regression was used to determine the influence of touch and walking experience (days since walk onset-walk age). Compared with adults, infants' sway was greater, more variable, and faster. Contrary to previous findings in upright standing, touch did not attenuate the sitting postural sway of adults. However, for the infants all measures showed significant effects for walk age, touch, and their interaction (all  $p < 0.05$ ). The walk age effect was due to a significant peak in all measures near the time of walk onset, regardless of touch condition. More important, the walk age-by-touch interaction indicated an attenuation of sway only during the transition to independent walking. These results extend the findings regarding touch as an important information source for postural tasks. Moreover, they demonstrate the influence of a developing behavior (walking) on a previously established behavior (sitting).

*Supported by NSF grant #9905315*

**A Study of Relationships Between Self-Handicap, Sport Motivation, and Goal Orientation on College Tennis Athletes in Taiwan**

Chen, W-L., K-H. Huang, C-C. Chou, C-H. Chen, M-Y. Huang, and W-Y. Wang.  
Taipei, Taiwan

This study examined the relationships between self-handicap, sport motivation, and goal orientation on college tennis athletes of Division I and II in Taiwan. There were 132 college tennis athletes (90 M, 42 F) which included 73 athletes from Div. I and 59 from Div. II. The Self-Handicap Questionnaire, Task and Ego Orientation Questionnaire, and Sport Motivation Questionnaire were administered to them. The statistical methods for data analysis in this study included *t*-test and Pearson correlation coefficient. The results of this study were as follows: (1) There was a significant difference between athletes of Div. I and II on task orientation, but significant difference on ego orientation. (2) There was no significant difference between athletes of Div. I and II on self-handicap. (3) There was a significant difference between athletes of Div. I and II on nonmotivation, but significant difference on intrinsic and extrinsic motivation. (4) There was a significantly positive relationship between task orientation, ego orientation, and extrinsic motivation. The results also showed that task orientation was significantly positively related to intrinsic motivation. (5) There were significantly negative correlations between self-handicap, intrinsic motivation, and extrinsic motivation in these college athletes, but significantly positive relationships with nonmotivation. (6) There were significantly positive relationships between intrinsic motivation and extrinsic motivation in these athletes, and extrinsic motivation was significantly positively related to nonmotivation.

**A Grounded Theory of Individual, Social Environmental, and Physical Environmental Influences on Physical Activity in African American Women**

Cherubini, J. Manhattan College

Despite numerous studies using correlational, prospective, and experimental designs, the literature remains inconclusive as to which variables relate to physical activity behavior change (Masse, Dassa, Gauvin, Giles-Corti, & Motl, 2002). Based on the findings of 91 studies on correlates of physical activity in women, Eyler et al. (2002) recommend the need for research including more diverse groups evaluating modifiable factors, such as psychological, interpersonal, and environmental correlates. The purpose of this study was to identify influences on physical activity that can be applied in interventions tailored to the adoption and maintenance of physical activity in African American women from an ecological perspective. Participants were 12 African American women, of whom 4 were physically active, 4 were physically inactive, and 4 were facilitators of physical activity programs. A descriptive qualitative design was used to gain insight into perceived influences on physical activity. Semi-structured interviews were conducted and an analysis of interview data using grounded theory (Strauss & Corbin, 1998) was employed. Based on the results, the developing theory includes the following elements: (a) individual influences, (b) social environmental influences, (c) physical environmental influences, (d) attitude, (e) attention, (f) action, (g) adherence, and (h) strategies for promoting change. To recognize how individual behaviors are developed and to discover the most effective ways to change these behaviors, it is necessary to acknowledge not only individual level characteristics but also the social and environmental conditions that affect their health behaviors. As practitioners, we need to target the multiple levels of influence that shape physical activity behavior, ranging from individual psychosocial variables to changes at the structural and policy levels.

**The Predictive Utility of Goal Involvement, Perceived Ability, and Sense of Control on Intensity and Direction of Precompetition State Anxiety**

Chi, L., and Y-C. Huang. Taoyuan and Taipei, Taiwan

The purpose of this study was to combine the achievement goal theory and Jones' control model of state anxiety examining the predictive utility of goal involvement, perceived ability, and sense of control on intensity and direction of precompetition state anxiety. Participants were 227 high school basketball players (139 M, 88 F) who competed in Division I of the 2002–03 National High School Basketball League in Taiwan. Their mean age was  $17.08 \pm 0.96$  years. After received informed consent from coaches and players, we assessed participants' goal involvement, perceived ability, expectancy of ability to cope, expectancy of goal attainment, and intensity and direction of state anxiety one hour prior to the basketball games. With respect to the effects of goal involvement and perceived ability on sense of control and state anxiety, the results indicated there were main effects of perceived ability on expectancy of ability to cope, expectancy of goal attainment, and both intensity and direction of cognitive anxiety. Specifically, high perceived-ability athletes reported higher expectancy of ability to cope and expectancy of goal attainment, lower intensity of cognitive anxiety, lower intensity of somatic anxiety, and interpreted cognitive anxiety as facilitative to performance compared to low perceived-ability athletes. There was also a main effect of goal involvement on expectancy of ability to cope and intensity of somatic anxiety. Specifically, athletes who were high task/high ego involved or high task/low ego involved reported higher expectancy of ability to cope and lower intensity of somatic anxiety than those who were low task/high ego involved or low task/low ego involved. With respect to the causal model testing, the results were consistent with the predictions of achievement goal theory and Jones' control model of anxiety. Specifically, goal involvements and perceived ability significantly predicted sense of control and intensity of state anxiety. Moreover, the direction of cognitive anxiety and somatic anxiety were significantly predicted by expectancy of ability to cope.

**Neurophysiological and Behavioral Modulations of Practice Effects Associated With Force Enslaving**

Chiang, H-h. Chung-Li, Taiwan

A well-known but not commonly studied electrocortical phenomenon in relation to finger force task performance is that of *interaction* (Heuer, 1991) or *enslaving* (Kilbreath & Gandevia, 1994). This is the situation in which individuals intend to move only one finger, yet involuntarily move other fingers as well. It is hypothesized that finger force enslaving is not a hard-wired phenomenon, as previously suggested (Schieber, 1991), but may be modified by deliberate practice which allows individuals to adopt new task-relevant neurocognitive strategy (Smith et al., 1999; Slobounov et al., 2000). This study examined the behavioral output and concomitant EEG patterns in time domains associated with independent finger control. The formation of task-relevant neurocognitive strategy was assessed in 6 college students using visual feedback and multifinger force production paradigms. The general topics being examined were the relationships between cortical activity and (a) the accuracy of force production, (b) rate of force development, and (c) force enslaving, as well as cortical reorganization as a function of practice. This study concluded that deliberate practice may partly overcome the structural limitations of the neuromuscular system by subjects adopting task-relevant neurocognitive strategies. This finding contributes to the larger scope of the literature on behavioral neuroscience regarding the issue of how the CNS is organized in order to sufficiently control the multiple motor outputs from the arm-hand complex.

### **A Study of the Leisure Benefits and Leisure Satisfaction Between Urban and Rural Female Recreational Sport Participants**

Chiu, S-L., C-C. Chou, C-C. Lin, W-Y. Wang, and C-H. Chen. Taipei, Taiwan

This study explored the differences in leisure benefits and leisure satisfaction between urban and rural female recreational sport participants. Leisure benefits and leisure satisfaction rating scales were used to measure the participants from two communities. Descriptive statistics were used to test the hypothesis and analyze the data. Concerning perceived leisure *benefits*, the results indicated that at the .05 level of significance: (a) urban participants scored higher than rural ones in balance life experience; (b) married participants scored higher than single ones in balance life experience, life wellness at .05 level of significance; (c) professional participants scored higher than housewives in balance life experience; (d) high educational level participants scored higher than low educational level ones in balance life experience; (e) younger participants scored higher than older ones in balance life experience; and (f) low income participants scored higher than high income ones in balance life experience. Concerning perceived leisure *satisfaction*, the results indicated that at the .05 level of significance: (a) urban participants scored higher than rural ones in relaxation and authentic experience; (b) married participants scored higher than single ones in relaxation and authentic experience; (c) professional participants scored higher than housewives in relaxation experience; (d) high educational level participants scored higher than low educational level ones in relaxation and authentic experience; (e) younger participants scored higher than older ones in relaxation; (f) high income participants scored higher in relaxation and physical and authentic experience than low income ones. There was a positive correlation between perceived benefits and satisfaction for both urban and rural female recreational sport participants at the .05 level of significance.

### **Self-Controlled Feedback is Effective if Based on the Learner's Performance**

Chiviacowsky, S.\*, G. Wulf, and T. Zachry. \*Universidade Federal de Pelotas, Brazil; University of Nevada Las Vegas

The study follows up on the contention that self-controlled feedback schedules are beneficial for learning because they are more tailored to the performers' needs than externally controlled feedback schedules (Chiviacowsky & Wulf, 2002). Under this assumption, one would expect to see learning advantages for individuals who decide whether they want to receive feedback after a trial rather than before a trial. Participants practiced a sequential timing task, and all participants could decide for which trials they wanted to receive feedback. One group of learners ("self-after") decided after every trial whether they wanted to be given feedback for that trial, while another group ("self-before") made that decision before each trial. The self-after group showed learning benefits on a delayed transfer test (novel absolute timing requirements) with regard to overall timing and relative-timing accuracy. Thus, self-controlled feedback was more effective when the learner could make a decision about the provision of feedback after the trial. This seems to provide support for the view that self-controlled feedback is typically beneficial for learning because learners can make the decision about feedback based on their performance on a given trial.

### **The Role of Procrastination in Resistance Exercise Prescriptions**

Ciccolo, J.T., and J.B. Bartholomew. University of Texas at Austin

The Centers for Disease Control (CDC) currently recommends that adults engage in moderate-intensity physical activities for at least 30 minutes, 5 or more days a week. This is intended to apply to aerobic exercise, with a different set of recommendations for resistance



training. However, this distinction is rarely emphasized. Because resistance exercise is intermittent rather than continuous, it is likely that this recommendation is inadequate, particularly for those who utilize extensive rest period between sets of an exercise. Thus it is important to consider dispositional characteristics that might predispose people to limit their exercise workload. One example is procrastination, postponing or delaying the performance of a task. Thus, given the opportunity for rest, those who score high in procrastination are likely to complete less physical work in the same bout of resistance exercise than those scoring low in procrastination. This study sought to determine the relationship between procrastination and acute resistance exercise behavior. Participants were 97 undergraduate college students recruited from weight-training courses offered by the university. Mean age was 20.5 ( $SD = 3.3$ ) with 67% male, and a mean body mass index of 23.7 ( $SD = 3.6$ ). All participants completed a self-administered questionnaire and then proceeded to do a 40-min, self-selected resistance exercise routine. Procrastination was assessed with the 16-item Procrastination Scale; level of exercise was measured as the volume and intensity of exercise completed within this 40-min class. Results showed that although self-rated exercise intensity was similar between procrastinators (those who scored 1  $SD$  above the mean) and nonprocrastinators (those who scored 1  $SD$  below the mean),  $p > .05$ , these groups did differ on exercise volume  $F(1, 34) = 9.77, p < .01$ , with procrastinators completing a lower volume of exercise. Thus, although both groups performed similar durations and intensity of exercise, the procrastinators completed less work. This suggests that a prescription for resistance exercise based on intensity and duration may be insufficient, leaving some people to fall short of their exercise goals.

### **The Impact of Self-Modeling and Self-Observation Interventions on the Self-Regulation of Learning**

Clark, S., and D. Ste-Marie. University of Ottawa

The purpose of this study was to compare the impact of a self-modeling intervention (viewing oneself perform an adaptive behavior), a self-observation intervention (viewing oneself perform at current skill level), or no intervention on beginner swimmers' self-regulation of learning. Based on Zimmerman's (2000) theory of self-regulated learning, the variables of self-efficacy, motivation, and self-satisfaction were examined. Thirty-three children between the ages of 6 and 10 participated in an 8-day intervention whereby they were randomly assigned to a self-modeling group, a self-observation group, or a control group. A series of one-way ANOVAs with the retention scores revealed a significant difference between the intervention groups for the self-efficacy, motivation, and self-satisfaction measures,  $p < .05$ . Post hoc testing showed that the self-modeling group indicated higher scores as compared to both the self-observation group and the control group for all three measures. Furthermore, for the motivation and self-satisfaction measures, the self-observation group indicated higher scores than the control group. Due to the importance of these variables in the self-regulation of learning (Schunk, 2001; Zimmerman, 2000), these results provide support for the implementation self-modeling interventions with children learning motor skills.

### **Autonomy Need Satisfaction as a Mechanism for an Indirect Effect of Coach Behavior on Youth Fear of Failure**

Conroy, D.E., and J.D. Coatsworth. The Pennsylvania State University

Fear of failure (FF) is a suboptimal form of achievement motivation based largely on the avoidance of shame (Atkinson, 1957). Among adolescents and young adults, hostile enmeshment characterizes high FF individuals' mental representations of coaches and par-

ents (Conroy, 2003). Accordingly, youth who fear failing may benefit from contexts that satisfy their needs for autonomy and relatedness (per self-determination theory; Ryan & Deci, 2002). This study examined the role of coach behaviors and psychological need satisfaction in predicting youth FF changes during a youth sport season. In the first week of a recreational summer swim league, boys and girls ( $N = 165$ ) ages 7 to 18 ( $M = 11.2$ ,  $SD = 2.2$ ) completed the Performance Failure Appraisal Inventory (PFAI) and rated the degree to which their basic needs for autonomy, competence, and relatedness were satisfied. In Week 4 they completed the PFAI again. In the sixth and final week they rated their coaches' behavior, completed the PFAI, and, at a separate time that week, rated the degree to which they felt their coaches satisfied their basic psychological needs. Conditional second-order latent growth curve analyses revealed that youth perceptions of coaches' affirmation, protection, control, and criticism at the end of the season did not predict the rate at which youth FF scores changed during the season,  $p > .05$ , but youth perceptions of coaches' affirmation significantly predicted the degree to which their needs for autonomy ( $\beta = 0.25$ ), competence ( $\beta = 0.43$ ), and relatedness ( $\beta = 0.44$ ) were satisfied in their relationship with the coach at the end of the season (after controlling for preseason levels of need satisfaction). Moreover, end-of-season autonomy-need satisfaction in youths' relationship with their coaches predicted the rate at which their FF scores changed ( $\beta = -0.83$ ); competence and relatedness need satisfaction were unrelated to the rate at which FF scores changed. These findings suggest that autonomy need satisfaction provides a mechanism by which coach behaviors may indirectly reduce FF.

### **Spatial and Temporal Motor Performance Characteristics Following Brief Exposure to Emotional Stimuli**

Coombes, S., C. Janelle, A. Duley, and R. Barnes. University of Florida

Previous work suggests that exposure to emotional stimuli influences spatial rather than temporal characteristics of subsequent motor performance. Accuracy of motor performance is enhanced following exposure to erotic and family-related images, as compared to neutral, threatening, or unpleasant images. In light of the speed-accuracy relationship, we refined a previously implemented protocol to maximize the impact of specific emotions on movement. Greater understanding of how emotion impacts overt motor output was achieved by more accurately coinciding the expression of emotion-specific physiological activation with motor performance. Speed and accuracy measures of a self-paced square tracing task were examined following exposure to 10 independent emotion eliciting stimuli: (1) AD = adventure; (2) FA = family; (3) EN = erotic nudes; (4) EC = erotic couples; (5) MUT = mutilations; (6) HA = human attack; (7) IN = insects; (8) SN = snakes; (9) HHO = household objects; and (10) MUS = mushrooms. Participants ( $N = 40$ ) viewed 1 slide per trial for 2 sec (40 total trials), and intertrial intervals were between 12 and 15 sec. Exposure to HA, SN, IN, HHO, and MUS led to increased speed relative to EC, EN, and FA. MU time was significantly less than EC time. Accuracy of performance did not vary as a function of category. Heart rate and skin conductance response generally distinguished categories. In summary, stimulus duration mediates speed and accuracy of performance differentially. Specifically, when compared to EC, EN, and FA stimuli, short exposure time to HA, SN, IN, HHO, and MUS images leads to increased error while increased exposure leads to increased speed. Recommendations for deciphering the dynamic relationship between affective stimulus duration and movement demands are provided, as are suggestions for future research.

### **Emotion and Motor Control: Movement Attributes Following Affective Picture Processing**

Coombes, S., C. Janelle, A. Duley, and R. Barnes. University of Florida

Poor understanding of the relationship between emotion and motor control is surprising, considering the salient advances emerging from affective research which have advanced the explanation, definition, and identification of how emotions are defined (Ekman & Davidson, 1994), how they manifest physiologically (e.g., Cacioppo, 2002), and how they subsequently influence behavior (Duckworth, Bargh, Garcia, & Chaiken, 2003). The purpose of these studies was to determine the impact of varying emotions on motor performance. We examined speed and accuracy of a self-paced square tracing task following exposure to pleasant (P), unpleasant (U), and neutral (N) visual stimuli. Participants ( $N = 39$ : 21 M, 18 F) viewed 4 consecutive same-category images (2 sec each) for a total of 8 sec immediately prior to completing a square tracing task. Forty experimental trials were completed. Error was greater following exposure to U and N images as compared to P images. Speed of performance did not vary as a function of valence. Self-report measures of arousal, valence, and dominance corroborated previous findings. Heart rate (HR) indexed attention rather than valence, and skin conductance response (SCR) followed expected trends. To resolve Study 1 issues and maximize emotional impact, in Study 2 we exposed 40 participants (19 M, 21 F) to 1 slide per trial for 2 sec, and intertrial intervals were lengthened. Speed of performance varied as a function of valence, with faster task completion being synonymous with U and N stimuli compared to P stimuli. Accuracy of performance did not vary between conditions. In summary, duration of exposure to affective stimuli differentially mediates speed and accuracy of subsequent motor performance, with exposure to U and N stimuli leading to either increased error (short exposure) or increased speed (multiple exposures) as compared to P stimuli. Similar performance characteristics following U and N stimuli requires further research. Finally, the shifting relationship between affective stimulus duration and the temporal and spatial characteristics of motor performance demands further scrutiny.

### **A Comparison of the Prevalence of Q-EDD-Based Disordered Eating Among Females in Aesthetic Sports, Non-Aesthetic Sports, and the General Population**

Cooper, A., D. Ste-Marie, and L. Stanley. University of Ottawa

The Questionnaire for Eating Disorder Diagnoses (Q-EDD) is a clinical tool developed by Mintz, O'Halloran, Mulholland, and Schneider (1997), and is used to place participants in disordered eating and nondisordered eating categories. It is unique in that it classifies eating behaviors along a 3-point continuum: asymptomatic (no eating disorder symptoms), symptomatic (some eating disorder symptoms, but not at the diagnosable level), and diagnosable eating disorder. Some researchers have shown female athletes, particularly those in aesthetic sports, to be at a higher risk for eating-disorder symptomatology than the general population (e.g., Sundgot-Borgen, 1993; Taylor & Ste-Marie, 2001). While the Q-EDD has been used as a diagnostic tool among various populations (Mulholland, 2001; Smart, 1999; Southerland, 2000), it has not yet been used with female aesthetic-sport athletes. This study is the first to do a comparison of Q-EDD-based disordered eating among female participants in aesthetic sports, non-aesthetic sports, and the general population. The participants, 144 female aesthetic-sport athletes ( $M$  age = 19.0,  $SD = 2.08$ ), 127 female nonaesthetic-sport athletes ( $M$  age = 19.7,  $SD = 1.67$ ), and 99 young women from the general population ( $M$  age = 20.6,  $SD = 2.10$ ), completed the Q-EDD. Results revealed that the aesthetic-sport group had significantly more symptomatic vs. asymptomatic participants when compared to the nonaesthetic-sport group,  $\chi^2(1, N = 370) = 5.04, p = .03$ . Discussion

will center around the possible utilization of the Q-EDD as a diagnostic tool for identifying at-risk populations, and for identifying symptomatic individuals who may gain from an intervention that prevents the onset of a diagnosable eating disorder.

### **Constant-Random Practice and Adaptive Process in Motor Learning: Effect of Different Quantities of Constant Practice on Motor Skill Acquisition**

Corrêa, U.C., J. Barros, L. Gonçalves, M. Massigli, and O.P. Souza. USP, Sao Paulo, Brazil

Research on a nonequilibrium model of motor learning as a theoretical background has shown that the adaptive process is benefited when the precedent process (stabilization) occurs under a constant-random practice regimen. However, we do not know the essential quantity of constant practice. Thus the purpose of this study was to verify the effect of different quantities of constant practice on motor skill acquisition using a complex coincident timing task. Participants were 30 children, both sexes, mean age 11.23 yrs ( $SD = 0.86$ ). The design evolved stabilization and adaptation phases and 3 experimental groups: constant-random criterion (C-RC), constant-random 33% (C-R33), and constant-random 66% (C-R66). During the stabilization phase, all groups performed in the constant practice regimen until they could perform 3 consecutive trials below  $\pm 50$  ms error. For the C-R33 and C-R66 groups, the practice in the same regimen was extended to 33% and 66%, respectively. The adaptive phase was identical in all groups that performed 36 trials in a random practice schedule manipulated by different velocities of visual stimulus and different response sequential patterns. Global performance (absolute, variable, and constant error) and movement pattern were analyzed. Invariant (relative timing, relative peak of force, and relative time of touch) and variant (overall absolute movement time, peak of force, and time of touch) aspects of the movement were also analyzed in order to evaluate the movement pattern. Two-way ANOVAs (3 Groups  $\times$  5 Blocks) showed similar performance for all groups in the adaptation phase, showing only an effect in blocks: absolute error,  $F(4, 108) = 5.12, p = 0.00$ ; variable error,  $F(4, 108) = 3.24, p = 0.01$ ; constant error,  $F(4, 108) = 14.08, p = 0.00$ . However, MANOVAs revealed differences in how adaptation took place. The C-RC group adapted without changing its structure, while the C-R33 group adapted by changing the relative timing, Wilks'  $\lambda = 0.10$ , Rao's (5, 6) = 11.10,  $p = 0.01$ ; and the C-R66 group adapted by changing the relative timing, Wilks'  $\lambda = 0.16$ , Rao's (5, 6) = 6.10,  $p = 0.02$ ; but also the relative time of touch, Wilks'  $\lambda = 0.18$ , Rao's (5, 6) = 5.32,  $p = 0.03$ . Two-way ANOVAs (3 Groups  $\times$  5 Blocks) showed an effect of blocks in overall absolute movement time,  $F(4, 120) = 3.25, p = 0.01$ . These results suggest that constant practice in motor skill acquisition might be performed until a criterion performance. After this, it seems there is no need for an increasingly consistent skill structure. Given that the C-RC group did not modify its skill structure, the C-R33 group changed one aspect, and the C-R66 group modified two aspects of the skill structure, these results also showed some hierarchy during the adaptation in terms of movement pattern.

### **Does "Romp Around the Neighborhood" and "Being Picked Last" in Childhood Explain Later Life Physical Activity?**

Cousins, S., and R. Benditt. University of Alberta

To explore how continuous lives are in terms of sport and physical activity participation, this retrospective descriptive study examined life course involvement in physical activity relative to three issues: most active time in life; activities as a 10-year-old child; and physical activity changes over the years. Recall questions were used during in-depth interviews with 30 respondents ages 49 to 82. An interpretive process of content analysis with constant thematic comparison within and across individuals was used to isolate common

themes and highlight unique life experiences. Surprisingly, childhood was not the most active time for all respondents, but for many, life tended to start out active and evolved over decades into sedentary living. Opportunities for childhood physical activity were enhanced by rural living and farm work, walking to school, programs of physical education at school, and “romping around” in the neighborhood with other kids. Bad experiences, such as being picked last for games, were remembered many decades later as reasons not to participate. Ordinary life events (marriage, employment, accidents, gaining weight, health issues) led to less physical activity by later life and demonstrated the social, psychological, and physical complexity of aging within a continuity perspective.

### **In Search of a Measure of Belonging**

Cox, A., and L. Williams. Purdue University

Belonging is an important social self-perception in youth physical activity motivation (Allen, 2003; Ntoumanis, 2001; Sarrazin et al., 2002; Standage et al., 2003). Educational researchers (e.g., Anderman, 1999; Goodenow, 1993a) have used various versions of the Psychological Sense of School Membership Scale (PSSM; Goodenow, 1993b), which is thought to reflect perceived classroom belonging and support/interest from peers and teachers, to assess belonging. Recently this inventory was modified for youth sport (Allen, 2003). Unfortunately, little is known about the structure of the PSSM for sport or the explanatory value of belonging. The purpose of this study was to examine the factor structure of a sport-specific version of the PSSM and the relationship of belonging with motivation-related constructs and loneliness. Two independent samples ( $N_1 = 183$ ,  $N_2 = 234$ ) of adolescent athletes completed the modified PSSM and established measures of self-determined motivation (Pelletier et al., 1995), enjoyment (Scanlan et al., 1993), and loneliness (Russell et al., 1980). The results of an exploratory factor analysis with Sample 1 yielded three interpretable factors explaining about 55% of the variance and reflecting belonging, being valued by coach and teammates, and attraction to team. Pearson product moment correlations revealed that belonging was related,  $p < .01$ , to sport enjoyment ( $r = .23$ ), social enjoyment ( $r = .54$ ), self-determined motivation ( $r = .29$ ), and loneliness ( $r = -.75$ ) in the anticipated directions. The results of a confirmatory factor analysis with Sample 2 demonstrated an acceptable fit to the data ( $\chi^2 = 190.27$ ,  $df = 74$ ,  $p < .001$ , RMSEA = .08, NNFI = .94, CFI = .95, GFI = .89) with one modification. Further, correlational results supported those found with Sample 1 with belonging relating to sport enjoyment ( $r = .25$ ) and self-determined motivation ( $r = .42$ ). These findings support a multidimensional factor structure underlying the PSSM and the utility of perceived belonging for understanding motivation and enjoyment in youth sport.

### **Intra-Saccadic Detection of Target Displacement for On-Line Control of Action**

Cressman, E., I. Franks, A. Martens, and R. Chua. University of British Columbia

Research on visually guided action has demonstrated that participants are able to correct their movements on-line in response to a change in target location during the saccade in the absence of conscious awareness (Pelisson et al., 1986; Prablanc & Martin, 1992). It is currently unclear when the change in target displacement becomes available for on-line control and how long the target must be available after its displacement for participants to modify their movements. To address this question, we adapted the classic double-step paradigm such that targets remained visible for varying lengths of time following displacement. Ten participants were instructed to make a pointing response to a target appearing in the periphery as quickly and accurately as possible. Each participant completed two testing blocks consisting of 360 trials each (180 single-step + 180 double-step). Targets initially

appeared in 1 of 4 possible locations and could either be displaced forward or backward or remain stationary during the initial saccade to the target. The target would then remain visible for 20, 60, or 2000 ms. Verbal reports, at the conclusion of the second testing block, indicated that all participants were unaware of the change in target position. In contrast, motor responses were correctly modified in the appropriate direction in response to target displacement in all three target durations. Furthermore, when the new target was extinguished prior to the end of the saccade (20-ms duration), participants were still able to process sufficient information during the saccade to bias their movements in the appropriate direction.

### **Athlete Burnout: A Longitudinal Qualitative Study**

Cresswell, S., and R. Eklund. University of Western Australia

Media controversy over a negative motivational state among players (e.g., Belfield, 2002; Hinton, 2002) stimulated the New Zealand Rugby Union to commission a study into players' experiences in professional rugby. There are several similarities between these media reports and research findings on athlete burnout in other sports (Coakley, 1992; Gould, Tuffey, Udry, & Loehr, 1996a; Silva, 1990). To date, however, research on athlete burnout has been limited by cross-sectional or retrospective research designs (Gould et al., 1996a; Gould, Tuffey, Udry, & Loehr, 1996b). Stress and burnout should be examined as a series of events, as previous instances of successful or unsuccessful coping is likely to influence future events (Folkman & Moskowitz, 2000). In the current study, professional rugby players ( $n = 9$ ) were interviewed three or four times over a 12-month period. Members of team management ( $n = 3$ ) were also interviewed at three time points to facilitate source triangulation and enhance trustworthiness. In the interviews some players reported experiences representative of burnout as described in the extant literature. In particular these interviewees reported experiencing the key characteristics of burnout, reduced accomplishment, physical and emotional exhaustion, and sport devaluation. Players reported feeling that they were not accomplishing as much as they should after instances of failure to meet performance goals or nonselection. In general, players' reports of physical exhaustion reflected fluctuations in playing and training loads. Emotional aspects of exhaustion were more closely aligned with incidents of frustration (e.g., performance, miscommunication). Sport devaluation was more prominent in later stages of the burnout experience. Players reported that previous instances of successful coping enhanced their appraisal and confidence for dealing with subsequent demands. In addition, players linked instances of unsuccessful coping to negative consequences (e.g., negative moods, antisocial behaviors) and negative appraisals in situations that followed. Overall, the results reflect the dynamic nature of the burnout experience and highlight the potential for further longitudinal research in this area.

### **Examining the Effects of Certain Types of Imagery on Psychological States: Further Support for Lang's Bioinformational Theory**

Cumming, J., N. Milan, and G. O'Brien. University of Birmingham

The aim of the present study was to test Lang's (1977, 1979) bioinformational theory of emotional imagery by comparing the effects of motivational general-arousal imagery (MG-A; i.e., images of anxiety and arousal) and motivational general-mastery imagery (MG-M; images of self-confidence) on competitive state anxiety symptoms. Ninety British athletes (57 M, 33 F) completed the MIQ-R (Hall & Martin, 1997) as a preliminary screening tool for imagery ability. They then completed the IAMS (Thomas, Hanton, & Jones, 2003) as if they were about to compete in a regular competition or match. Next they were randomly assigned to one of three imagery scripts describing a hypothetical competition: MG-A imagery only, MG-M imagery only, and a combination of MG-A and MG-M imagery.

After imaging their assigned script, each athlete completed the IAMS for a second time and a postexperimental manipulation check. Separate  $3 \times 2$  (Imagery group  $\times$  Time) repeated-measures MANCOVAs were performed on the data with gender and sport type serving as the covariates and the dimensions of cognitive anxiety, somatic anxiety, or self-confidence operating as the dependent variables. The results indicated that in comparison to Time 1, athletes in the MG-A imagery group reported significantly higher levels of cognitive and somatic anxiety symptoms, more debilitating interpretations of somatic anxiety symptoms, and lower levels of self-confidence. Athletes in the MG-M imagery group reported significantly lower levels of cognitive and somatic anxiety symptoms, more facilitative interpretations of somatic anxiety, and higher levels of self-confidence. Finally, athletes in the MG-A/MG-M imagery group perceived no changes in their anxiety intensity, but reported more facilitative interpretations of somatic anxiety and higher levels of self-confidence. The results demonstrate support for Lang's proposal that certain types of images will generate physiological and emotional responses.

### **Perceptual and Motor Dynamics Interact in Bimanual Coordination**

DaSilva, F., and E.L. Amazeen. Arizona State University

Our intrinsic motor dynamics are such that we easily perform two bimanual phase relations, in-phase ( $0^\circ$ ) and anti-phase ( $180^\circ$ ). Phase relations near  $0^\circ$  are more stable than those near  $180^\circ$ . Intermediate phases are more difficult. Meschner et al. (2001) showed, however, that even difficult forms of multifrequency bimanual coordination (e.g., 5:4) can be performed when visual feedback is modified to represent a simpler frequency ratio (e.g., 1:1). The present study extended this finding to relative phase coordination by presenting perceptual feedback that differed from the actual movements produced. Seventeen participants swung hand-held pendulums while attending to visual feedback about relative phase (a real-time phase plot of each pendulum) displayed on a screen. They were to maintain in-phase or anti-phase coordination in the visual display. The visual feedback varied from what participants actually performed in  $15^\circ$  increments from  $0^\circ$  to  $360^\circ$  so that they would perform, for example,  $15^\circ$  in order to maintain the display at  $0^\circ$ . Participants were able to approximate the required phases but were drawn toward performing the nearest stable phase ( $0^\circ$  or  $180^\circ$ ). Furthermore, the strength of the attraction toward performing  $180^\circ$  was greater when participants maintained the visual display at  $180^\circ$ . This suggests that perceptual and motor dynamics interact in the resulting bimanual coordination. Similarly, standard deviations of relative phase were minimized when performing  $0^\circ$  and  $180^\circ$  and were uniformly smaller when participants were maintaining the visual display at  $180^\circ$ . Relaxing the degree to which performance could be gauged visually (in the anti-phase condition) relaxed the degree to which visual feedback interfered with the intrinsic motor dynamics.

### **The Struggle for Maintenance: Performance Loss in Elite Golfers Across a 25-Year Period**

Deakin, J., J. Baker, and S. Horton. Queen's University

Given the time and effort required to attain high levels of skilled performance, maintaining this performance in the face of advancing age is an important concern for many athletes. Starkes and colleagues (Starkes, Weir, Singh, Hodges, & Kerr, 1999; Starkes, Weir, & Young, 2003) and Deakin, Baker, and Horton (2003) found that a high level of sport involvement could delay the onset of performance decline that is thought to be inevitable with age. Golf provides an excellent avenue for examining the loss of skill with advancing age because it allows continued play throughout life even for elite players. This study examined the career performance of 18 golfers who met the criteria of: (a) winning at least 5 tournaments on the Champions Tour; (b) playing most of their senior career on the Champi-

ons tour; and (c) playing regularly on the PGA tour from 35 to 50 years of age. The mean age for this group was 64.4 years. Internet web sites were used to collect data for each golfer's seasonal scoring average and number of tour rounds played each year from age 35 to age 60. Analyses indicated a stable decrease in performance with age, but the decline was relatively small. Furthermore, the rate of performance decline was greater from ages 50 to 60 than from ages 35 to 49. More specifically, the decline in average performance on the PGA tour (i.e., for ages 35–49) was 0.06 strokes per year, while the decline on the Champions Tour was 0.18 strokes per year. A look at the number of rounds played provided a unique profile. Typically golfers averaged 91 rounds at 35 years, which steadily declined to 29 rounds at 49 years. However, the number of rounds played on the Champions Tour (i.e., after 50 years of age) dramatically increased to a high of 83 rounds at 51 years of age. Furthermore, this trend of high participation continued for the period from 50 to 60 years of age. Discussion will focus on the relationships among time spent in practice/training, time spent in competition, and the maintenance of performance over time.

### **Expertise in Show Jumping: An Exploratory Comparison of Adjustments and Adjustment Recall in High and Low Skilled Equestrians**

DeBeck, L., C. MacMahon, and J.L. Starkes. McMaster University

A recent model of acquisition and retention of perceptual-motor skill presents two streams of functioning (Starkes, Cullen, & MacMahon, 2002). The perceptual-motor (PM) stream includes skills that involve perceiving and doing, whereas the perceptual-cognitive (PC) stream includes skills that involve perceiving and understanding. Very few studies in the literature on expertise have examined both streams within one task. This study explored this gap by examining expertise in equestrian show jumping. As a horse and rider approach a jump, the rider must adjust the animal's stride in order to arrive at an appropriate place for takeoff. This is termed "finding a distance." We examined adjustments made by riders (PM skill) as well as recall of adjustments (PC skill). Specifically, 6 high- and 6 low-skilled equestrians were filmed in their approaches to three jumps. They were then questioned on adjustments they made during these approaches. The film was digitized and measurements for the hip, knee, and shoulder angles were examined and compared with the participant's recall. Overall, the high-skilled group showed less variation in the aforementioned angles. Furthermore, a Mann-Whitney-U revealed that the high-skilled group had significantly better recall of movements. Several limitations of this study restrict the application of the results. However, the differences in both PC and PM skills warrant future research into the specificity of these differences.

### **The Relationships Between Psychological Needs, Contextual Motivation and Affects Among Intramural Sport Participants**

Destani, F., and M-S. Kim. San Francisco State University

Stemming from self-determination theory (Deci & Ryan, 1991), the present study examined affective consequences at the contextual level by assessing psychological needs (perceived competence, relatedness, and autonomy) and motivational indices (intrinsic, identified, external, and amotivation). A total of 169 participants from an intramural sport program completed a multisection inventory which consisted of the SIMS (Standage et al., 2003), the three basic psychological needs (Standage et al., 2003), and the PANAS (Watson et al., 1988). The results of multiple regression analyses revealed that autonomy was positively related with self-determined forms of motivation (intrinsic and identified,  $\beta = .22$  and  $.15$ , respectively) and negatively with external regulation ( $\beta = -.15$ ) and amotivation ( $\beta = .27$ ). Although statistically insignificant, perceived competence showed a positive association with self-determined forms of motivation ( $\beta = .14$  for intrinsic and  $.17$  for identified).



Meanwhile, relatedness was negatively related to external regulation and amotivation ( $\beta = -.14$  and  $-.14$ , respectively). Positive affect was predicted positively by two basic needs, i.e., perceived competence ( $\beta = .21$ ) and relatedness ( $\beta = .35$ ), whereas negative affect negatively corresponded to those constructs ( $\beta = -.23$  and  $-.23$ , respectively). In terms of relationships between motivational indices and affects, positive relationships emerged between intrinsic motivation and positive affect ( $\beta = .23$ ) and a negative association with negative affect. Amotivation revealed a negative link to positive affect ( $\beta = -.17$ ) and a positive association with negative affect ( $\beta = .33$ ). These findings will be further discussed in light of self-determination theory.

### **Manipulating Visual Information Alters Postural Stability Among Parkinson's Patients**

Doan, J., S. Cooper, S. Tiede, S. Pellis, I. Wishaw, O. Suchowersky, and L. Brown.  
University of Lethbridge

Parkinsonian (PD) patients exhibit deficits in the ability to re-integrate and reweigh sensory information for postural control. However, knowledge regarding the independent effect of vision for postural control among PD patients remains limited. In this study we manipulated visual information to determine the ability of PD patients to reweigh and re-integrate visual information for the control of upright standing. Six healthy older adults (mean age 67.8 yrs) and 6 PD patients (mean age 65.7 yrs) were included in this study. PD patients were tested both ON and OFF levodopa medication. Participants stood on a forceplate (Bertec) with their feet a comfortable width apart for a 45-sec test trial during which visual information was alternately withdrawn and made available across three 15-sec time intervals (full vision: 0 to 15 sec; no vision: 15 to 30 sec; full vision: 30 to 45 sec) using liquid crystal vision occlusion goggles (PLATO®). The ability to reweigh sensory inputs for postural control was determined by removing visual information for a prolonged time period (15 sec). Re-integration ability was tested by making visual information available after a prolonged absence (15 sec). Five time frames were selected for analysis: (1) Full-vision baseline (10 to 15 sec); (2) No-vision short-term (15 to 20 sec); (3) No-vision long-term (25 to 30 sec); (4) Re-integration short-term (30 to 35 sec); (5) Re-integration long-term (40 to 45 sec). Withdrawing visual information disrupted postural stability in PD patients, but the magnitude of this disruption increased in no-vision long-term for PD ON. Interestingly, postural stability stabilized to baseline levels when visual information was restored. These results imply that levodopa medication may adversely affect the ability to reweigh sensory inputs for the control of posture and presents the possibility of risk of falls in environments of reduced or conflicting sensory information.

### **Factors That May Contribute to the Slowing of RT to a Nonspeeded Secondary Task**

Dornier, L., M. Hart, N. Schott\*, and T.G. Reeve. Texas Tech University; \*Institute of Sport Science, Geissen, Germany

Research has shown that reaction time (RT) to a primary task is slowed when paired with a speeded secondary task (i.e., complexity effect). However, research on the complexity effect involving a nonspeeded secondary task has yielded conflicting results. The purpose of the present experiments was to examine possible factors that may contribute to this effect. Experiment 1 manipulated the certainty of the direction of the secondary task in order to examine whether previous results were due to participants programming the entire movement even for the nonspeeded task. In this experiment, 22 participants performed in 4 conditions: finger lift (control); speeded; nonspeeded known; and nonspeeded unknown. The primary task for the three experimental conditions required a finger lift followed by a

secondary task that required a grasp of an object that was located to the right or left of the body midline. In the speeded condition, participants were instructed to perform the primary and secondary tasks as quickly as possible. In the nonspeeded conditions they were told to perform the primary task as quickly as possible, wait 2 sec, then perform the secondary task. In the unknown condition, the direction of movement was indicated only after the 2-sec delay. Results indicated slower RTs for all 3 experimental conditions. However, there was no difference as a function of certainty of the secondary task (known vs. unknown). A possible cause for conflicting results in previous experiments may be due to the participants' failure to lift their finger as quickly as possible in the nonspeeded conditions. The purpose of Experiment 2 was to encourage participants to execute the finger lift as quickly as possible. Participants ( $N = 16$ ) in this experiment completed 4 conditions that manipulated speeded vs. nonspeeded movements with or without a trip wire. They were instructed to trip the wire with their finger as quickly as possible. RT data indicated no significant effects. The two experiments considered a variety of conditions that could have contributed to the nonspeeded secondary task effect. However, none of these conditions provided a clear explanation of the effect.

### **Generalizability of Force Plate Measures**

Doyle, R.J., B.G. Ragan, L.A. Melnyk, E.T. Hsiao-Wecksler, and K.S. Rosengren.  
University of Illinois

Force plate measures during quiet standing are commonly used in research. The number of trials varies greatly between studies with little documentation of reliability. The purpose of this study was to establish reliability estimates for common quiet standing force plate measures. Seven participants (3 M, 4 F; age  $20.0 \pm 1.2$  yrs, Ht  $1.79 \pm 0.1$  m, Wt  $76.33 \pm 12.7$  kg) completed this study. They were asked to stand as still as possible on a platform for 30 sec. They completed 10 trials with eyes open followed by 10 trials with eyes closed. Participants stood as still as possible with arms to the sides while staring at a spot on the wall approximately 5 meters in front of them. This sequence was repeated a second time within a week of the first data collection period. An AMTI force plate was used to collect all data. Reliability estimates for center of pressure (COP) standard deviations in the anterior-posterior (AP) and mediolateral (ML) directions and area were calculated. Generalizability theory through a G study and follow-up D studies were performed to estimate reliability coefficients (G- and Phi coefficients). Intraclass correlation coefficients (ICC) were also calculated and can be considered a special case of Generalizability theory. A reliability coefficient of 0.80 or greater is desired. The facets included were person (P), days (D), and trials per day (T:D). The measurement model used was Person  $\times$  Trials nested in days (P  $\times$  T:D). The AP G-coefficients ranged from 0.13 for one trial to 0.83 for 10 trials. The AP ICC ranged from 0.59 to 0.91. The ML G-coefficients ranged from 0.09 to 0.62, and the ICC were 0.70 to 0.91. The area G-coefficients were 0.22 to 0.83, with ICC ranging from 0.60 to 0.87. The measurement models that could meet the desired reliability (i.e., coefficient = 0.8) were 10 trials for AP and area in one testing session. The ML results indicated the need for more trials in order to achieve the desired reliability. Overall, the COP measures were reliable when enough trials were performed. Researchers should be cognizant of the need for more trials in establishing reliable measures.

### **Challenging the Optimal Challenge Point Model**

Dubrowski, A., S. Ravi, J. Park, R. Brydges, and H. MacRae. University of Toronto

Learning specificity theory explains that the closer the practiced task resembles the task that must be performed in the real world, the more functional the learning will be. Does it hold across expertise levels? According to the optimal challenge point model (Guadagnoli

& Lee, 2003), the functional difficulty of practice should be adjusted to the trainees' current performance level in order to be most beneficial to the learning process. The purpose of this study was to investigate whether practice of complex surgical skills can benefit from this new approach. Two groups of junior (no prior experience) and two groups of senior (extensive experience) surgical residents practiced vascular anastomosis (joining two vessels) on either high or low fidelity models. The low fidelity model consisted of synthetic tubes. Cadaver arms were used as a high fidelity model. After a week retention period, performance was re-assessed on a live animal model. Technical performance was assessed with hand motion efficiency analyses. Learning of the anastomosis procedure was influenced differentially by model complexity for the two expertise groups. For the senior residents, the more realistic the practice model, the better the transfer to the animal model. The junior group showed poorer performance on the animal model compared to the seniors, and they were not influenced by practice model fidelity. This is consistent with learning specificity theory, as well as with the optimal challenge point model.

### **Active Exploratory Training for Infants With Brachial Plexus Birth Palsy**

Duff, S.<sup>1</sup>, A.N. Bhat<sup>2</sup>, J.C. Heathcock<sup>2</sup>, S.H. Kozin<sup>3</sup>, and J.C. Galloway<sup>2</sup>. <sup>1</sup>Wyndmoor, PA; <sup>2</sup>University of Delaware; <sup>3</sup>Shriners Hospitals for Children, Philadelphia

Active exploration is critical in early motor development, yet infants who sustain a unilateral injury to the upper brachial plexus (Erb's palsy) at birth are at a disadvantage due to a reduction in active motion in the involved arm. This case study format studied three variations of training to foster active motion in the involved arm. Three 3-month-old infants with Erb's palsy participated in a 1-month program from 3 to 4 months of age. **Methods:** Measurements taken before and after the program included active arm motion using the Active Movement Scale (AMS), motor function using the Alberta Infant Motor Scale (AIMS), passive shoulder range-of-motion, and 3-D motion analysis. Each infant's program included interaction with an overhead mobile for 10 minutes, 3 times per day at home, and weekly occupational or physical therapy. Each infant interacted with the mobile through either: (a) a bimanual, (b) a unimanual, or (c) an unrestrained approach. **Results:** Active motion in the involved arm of all infants improved to varying degrees, yet the one who used the unimanual approach improved the most. She had a 6% increase on the AMS, progressed from 60th to 85th percentile on the AIMS, and displayed more active elbow flexion during reaching than the others. The infant who used the bimanual approach improved 4% on the AMS and scored in the 50th percentile on the AIMS at both intervals. However, each of those infants began with active elbow flexion. The infant who was unrestrained improved 2% on the AMS. She began in the 40th percentile on the AIMS without active elbow flexion, yet after the program scored in the 50th percentile and displayed active elbow flexion. **Conclusion:** The results suggest that the use of an overhead mobile may foster active use of the involved arm in infants with Erb's palsy. However, the best approach to the mobile still remains to be determined. Furthermore, future research will need to determine the degree of nerve trauma prior to program participation, and thus clearly delineate which infants would best benefit from movement training based on recovery potential.

### **Fear of Failure: Affective and Attentional Processing of Success and Failure Stimuli**

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Fear of failure (FF) exhibits conceptual and empirical similarity with performance anxiety, and appears to engage motivational and emotional systems to cope with potentially

aversive consequences. Researchers have primarily focused on how FF predisposes individuals toward specific goals for demonstrating competence; however, little is known about other consequences of FF, principally with regard to its interaction with affective responsivity and allocation of attention. The purpose of this study, therefore, was to examine attentional biases among individuals differing in levels of FF as they viewed words and pictures depicting assorted thematic content. Indices of natural selective attention (viz., viewing time and self-reported affect) were assessed among college students engaged in a self-paced slide-viewing task. FF was found to be negatively associated with self-reported dominance and pleasantness for sport-failure and unpleasant-themed stimuli. Furthermore, FF was positively related with arousal ratings for unpleasant pictures, and a significant positive relationship between FF and viewing time for sport failure pictures emerged following removal of the variance initially suppressed by neuroticism. In contrast, FF was not significantly related to affective or attentional consequences of viewing pleasant or sport success-related images. Results are discussed in the context of current theories of emotional reactivity and attentional biases pertaining to the nature of FF as compared to other affective pathologies. These findings may provide insight into mechanisms by which maladaptive aspects of FF are maintained. Additionally, these attentional and affective processes may provide alternative criteria for evaluating the efficacy of interventions to reduce FF.

### **Perfectionism, Trait Anger, and Anger Expression in High-Performance Youth Canadian Football Players**

Dunn, J.G.H., B.B. Babiak, J. Causgrove Dunn, and D.G. Syrotuik. University of Alberta

This study examined the relationship between perfectionist orientations and anger among 139 high-performance teenage male Canadian football players ( $M$  age = 18.30 years,  $SD = 0.75$ ) from 5 provincial-select teams. Athletes completed the Sport Multidimensional Perfectionism Scale (MPS-Sport: Dunn, Causgrove Dunn, & Syrotuik, 2002) and a sport-modified version of Spielberger's (1999) State Trait Anger Expression Inventory-2 (STAXI-2). The STAXI-2 was used to measure athletes' general anger dispositions (i.e., trait anger) and the typical manner in which athletes express and control their anger responses during competition. All subscales in the inventories had acceptable levels of internal consistency ( $\alpha$ s > .70). Separate canonical correlation ( $R_c$ ) analyses were used to examine the multivariate relationship between perfectionism and (a) trait anger, and (b) anger expression/control. In the first analysis the two trait anger subscales (Angry temperament, Angry reaction) comprised the criterion set. In the second analysis the four anger expression/control subscales (Anger control in, Anger expression in, Anger control out, Anger expression out) comprised the criterion set. The four MPS-Sport subscales (Personal Standards [PS], Concern Over Mistakes [COM], Perceived Coach Pressure [PCP], Perceived Parental Pressure [PPP]) comprised the predictor set in both analyses. One significant canonical function was extracted from each analysis. In the first analysis a profile resembling maladaptive perfectionism (i.e., moderate positive canonical loadings on PS, COM, and PCP) was positively correlated with a canonical variate resembling high trait anger ( $R_c = .42, p < .001$ ). In the second analysis another profile of maladaptive perfectionism was positively correlated with a canonical variate resembling a high inward expression of anger ( $R_c = .50, p < .001$ ). Results suggest that maladaptive perfectionist athletes are not only predisposed to experiencing anger but may also have difficulty finding an appropriate release for the anger they experience during competition.

### **The Effect of Visual Manipulation on Running Stability**

Eaves, D.L.\*, N.J. Hodges, and A.M. Williams. \*University of Teesside; Liverpool John Moores University

Mechsner and colleagues (2001) suggested that the visual/spatial characteristics of movement are those that dominate interlimb stability, rather than constraints inherent in the motor system. Moreover, Schmidt et al. (1990) showed how the underlying principles of within-person interlimb coordination are also applicable to between-person coordination. In both studies, coordination was an emergent rather than an enduring property of the visual display. The objective in this study was to explore the implications of being visually coupled with a dynamic symmetrical image (i.e., a mirror image), a dynamic asymmetrical image (a reverse mirror image in the medial sagittal plane), and a static image while running on a treadmill. Recreational runners ( $N = 8$ ) were assessed using three indicators of movement stability: movement economy (metabolic energy expenditure and heart rate), reaction time (RT), and movement kinematics, as well as subjective reports of perceived physical exertion and mental effort. They ran each of their three experimental runs at 60%  $\text{VO}_2$  max for 15 min and then the speed was increased to 80%  $\text{VO}_2$  max for the final 5 min. Repeated-measures ANOVA revealed that a greater level of movement stability was afforded when runners were coupled symmetrically, compared to when they were visually coupled with a reversed and static image. Significant differences in metabolic energy expenditure were observed across the three conditions at 80%  $\text{VO}_2$  max. Furthermore, RT and subjective reports indicated that the cognitive and mental effort required was greater when runners were coupled with a reversed visual image in comparison to symmetrical and static images. It appears that running while coupled symmetrically (i.e., in-phase), rather than with a reversed or static image, affords a more cognitively and physiologically efficient movement profile, especially at fast speeds.

### **Thinking Outside the Box: The Role of Environmental Adaptation in the Acquisition of Expertise in Sport**

Eccles, D.W. Florida State University

Current theories of expertise in sport postulate that experience and practice lead to increased domain-specific knowledge, which in turn leads to cognitive adaptations to the target domain. These adaptations are in the form of cognitive strategies that increase information-processing efficiency and effect a circumvention of processing limitations. Recent research has shown how domain-specific knowledge also leads to environmental adaptations to the target domain (Kirsch & Maglio, 1994). These adaptations are in the form of environmental strategies that decrease the onset of cognitive work and thus effect a circumvention of processing limitations. In orienteering, evidence has been presented of how experts develop cognitive strategies, such as attentional scheduling strategies, to circumvent the attentional bottleneck that results from a key task constraint, which is the requirement to attend visually to the map, features in the terrain, and running, simultaneously (Eccles, Walsh, & Ingledew, 2002). The present study used interview data obtained from 20 expert orienteers to demonstrate how environmental strategies are also used to circumvent the bottleneck. One strategy includes folding the map around the area displaying the orienteering course so that when the orienteer has to attend to the map, visual location of his or her present position on the map is made easier through a reduction of the spatial area requiring visual search. Another strategy is "thumbing," which involves gripping the map such that a thumb is placed on the map and points to the orienteer's position. This makes visual location of this position easier by introducing a perceptual singleton into an otherwise detailed visual display. The implication of this research for the understanding of expertise is that the

loci of adaptations that effect a circumvention of processing limitations often lie outside as well as inside the head.

### **Why an Expert Team is More Than a Team of Experts: A Cognitive Conceptualization of Team Coordination and Communication in Sport**

Eccles, D.W., and G. Tenenbaum. Florida State University

Cognitive processes in sports teams are rarely studied. Consequently, a cognitive conceptual framework for the study of team coordination and communication is presented, along with methods for studying these concepts in sports. This framework is based largely on research in industrial and organizational psychology. Team coordination, which can be achieved only by effective team communication, is essential to team performance. In effect, a team must undertake two tasks: the target task itself and the task of coordinating the teams' actions toward the target task. This is known as the taskwork/teamwork distinction. Thus, teamwork imposes demands on a team's cognitive resources that are additional to the demands of the task per se. There are also knowledge requirements for team coordination. First, team members must acquire teamwork knowledge, which is knowledge of the likely responses of the overall team to a given event, and how and when their own actions are to be integrated with those actions. Second, a subset of each member's knowledge must be at least similar to a subset of this knowledge held by other members, such that some knowledge is shared by all members. The extent to which a team shares teamwork knowledge is related to the experience of the team and engagement in pre-event team planning. Achieving the shared knowledge required for coordination relies on team communication. During an event, communication affects the team's ability to update members about changes in the event status and intended responses to those changes. Experienced teams share a common verbal nomenclature that increases communication efficiency. Members of experienced teams are also able to interpret unintentional nonverbal communication, in the form of actions, from fellow members and thus can anticipate upcoming responses and coordinate their own actions accordingly. The framework presented here affords hypothesis generation for empirical research on coordination and communication in sports teams and a theoretical base with which to reconcile the resultant data.

### **Reasons for Exercise in High and Low Body Dissatisfied Overweight and Obese Women**

Ellis Gardner, R.<sup>1</sup>, and H.A. Hausenblas<sup>2</sup>. <sup>1</sup>Louisiana State University; <sup>2</sup>University of Florida

Body dissatisfaction may be a determinant of or a barrier to exercise participation that varies by population. Thus the purpose of this study was to examine if body dissatisfaction moderates the reasons for exercise in overweight and obese women. Participants were 115 overweight and obese women ( $M$  age = 31.80,  $SD$  = 12.47;  $M$  BMI = 28.88,  $SD$  = 5.20) participating in a 4-week exercise program. Participants completed the Reasons for Exercise Inventory (REI; Silberstein et al., 1988) and the body dissatisfaction subscale of the Eating Disorder Inventory-2 (EDI; Garner, 1991). Participants were divided into high ( $n$  = 57,  $M$  = 23.28,  $SD$  = 2.97) and low ( $n$  = 58,  $M$  = 11.34,  $SD$  = 4.02) body-dissatisfied groups based on the body dissatisfaction subscale scores. Results of the MANOVA revealed group differences for body dissatisfaction and reasons for exercise, Wilks'  $\lambda$  = .236,  $F(8, 101)$  = 40.818,  $p$  < .0001. Follow-up univariate analyses showed that the high body-dissatisfied group reported more body dissatisfaction than the low body-dissatisfied group,  $p$  < .0001. Furthermore, the only group difference on the REI was that the high body-dissatisfied group reported that exercising to improve mood ( $p$  = .023) was more important than was reported

by the low body-dissatisfied group. This is interesting because greater body dissatisfaction is associated with appearance and weight control reasons for exercise in college-age women (Cash et al., 1994). This suggests that for overweight and obese women, the motive to exercise to improve physical appearance or for weight control is equally important for individuals reporting high and those reporting low body dissatisfaction. In addition, it appears that high body-dissatisfied overweight and obese women are more motivated to exercise to alleviate the mood disturbances associated with body image concerns than their low body-dissatisfied counterparts. These findings have important implications for exercise intervention design for overweight and obese women.

### **Comparisons Between the Sexes for Balance and Reaction Time Tasks**

Etnyre, B.<sup>1</sup>, and P. MacRae<sup>2</sup>. <sup>1</sup>Rice University; <sup>2</sup>Pepperdine University

Few studies have examined balance and reaction time performance between males and females. Results from studies which compared balance performance of healthy men and women have been mixed, as some reported that women had better balance while others reported that men had better balance. Several studies reported faster simple visual reaction times for men and women, but rarely reported results for simple auditory or choice reaction time conditions. The present study compared balance and reaction time performances between men and women. Correlations were also calculated between average balance times and reaction times in each gender to determine the relationship between the two tasks. A total of 236 participants (135 M, 101 F; average age  $21.6 \pm 1.1$  yrs) performed 10 balance task trials on a stabilometer during each of two sessions (acquisition and retention) on separate days. Measurements were recorded as time on balance during each 30-sec trial. During another test session, data for one-choice visual, one-choice auditory, and 4-choice visual reaction time tasks were recorded for 195 participants (105 M, 90 F). Women exhibited significantly better balance performance than men,  $p < .05$ , during acquisition (18.0 vs. 16.9 sec) and retention (23.3 vs. 21.9 sec). Significantly faster reaction times ( $p < .001$  for each task) were observed for men compared to women for simple auditory (223.5 vs. 247.6 msec), simple visual (243.5 vs. 269.3 msec), and choice visual (389.4 vs. 417.6 msec) reaction times. For correlations between tasks, the data from 174 participants (91 M, 83 F) who completed all the balance and reaction time tasks were used. Correlations between average balance time and average reaction time, for each reaction time condition, were low positive (M:  $r = .17$  to  $.24$ ; F:  $r = .07$  to  $.20$ ), which suggests that the tasks had little if any relationship. The gender differences found for these tasks may be related to genetic, anatomical, environmental, or sociological factors.

### **Task Switching Costs in the Absence of Categorical Decision-Making Demands**

Fairbrother, J. University of Tennessee Knoxville

Both top-down executive control processes (e.g., response selection) and bottom-up task-specific processes (e.g., recency) have been identified as possible sources of the cost of switching between decision-making tasks (Ruthruff, Remington, & Johnston, 2001). Switch cost is measured in terms of the difference in performance that occurs when individuals alternate between two or more tasks vs. when they repeat the same task. Since decision-making paradigms used in most previous research require a choice prior to a response (e.g., deciding whether a presented number is odd or even and pressing the key that corresponds to the correct category), it remains to be determined whether bottom-up factors contribute to the switch cost independently of top-down factors. The purpose of the present experiment was to determine whether a switch cost would be evidenced if participants alternated between two tasks that required no categorical decision-making. An anticipation timing

(AT) task was chosen because such tasks rely predominately on perceptual processes, which have been shown to be influenced by the bottom-up factor of recency (Epstein & Rock, 1960). Participants performed 40 trials of a 3-mph AT task in either a repeated fashion (Rep) or alternating with a 6-mph task (Alt). Top-down factors of preparation time and expectancy were controlled across both conditions. Results indicated significantly larger absolute constant error (ACE) and absolute error (AE) for the Alt condition vs. the Rep condition, with switch cost stable across all four trial blocks,  $p < .01$ . A chi-square analysis of the distribution of responses revealed an early bias in the Alt condition,  $p < .05$ , but not in the Rep condition. Thus it was concluded that some proportion of switch costs observed in previous studies were due to bottom-up, task-specific processes that operated independently of the requirement to make a categorical decision.

### **The Influence of Bottom-up Factors in Practice Schedule Effects During Motor Skill Performance**

Fairbrother, J., and S. Brueckner. University of Tennessee Knoxville

Prominent explanations of contextual interference (CI) effects (Lee & Magill, 1983, 1985; Shea & Zimny, 1983, 1988) have not adequately addressed mechanisms that can explain the performance difference between blocked and random practice schedule conditions when individuals first acquire novel motor skills. While both explanations include top-down executive control processes (e.g., effortful processing and intertask comparisons) and bottom-up automatic processes (e.g., forgetting and elaboration) in their accounts of how learners manage task performance during the learning of multiple tasks, neither one identifies how these two levels of processing might operate independently. Research on switch costs in categorical decision-making tasks points toward preparation and expectancy as two possible top-down factors that cause degraded performance when a participant alternates between two tasks compared to when he or she repeats a single task (e.g., Ruthruff, Remington, & Johnston, 2001). In addition, a proportion of switch cost has been attributed to bottom-up factors such as recency and activation. The similarity between task switching and CI protocols suggests it would be fruitful to isolate top-down and bottom-up factors that operate in blocked and random practice of motor skills. Lee and Magill (1983, Exp. 1) demonstrated that unpredictability (i.e., expectancy) contributed to practice schedule differences. The purpose of the present study was to determine whether a difference between repeated and alternating task performance would be revealed when top-down factors were controlled. Participants completed 50 trials of an impulse-transfer task either in a repeated (Rep) fashion or alternating (Alt) with another task. Results indicated significantly larger constant error (CE) for the Alt condition compared to the Rep condition for a 30-cm target,  $p < .01$ . It was concluded that acquisition differences between blocked and random practice cannot be exclusively attributed to top-down factors.

### **The Role of Preparation in Task Switching Cost for a Simple Motor Skill**

Fairbrother, J.<sup>1</sup>, J. Shea<sup>2</sup>, T. Parry<sup>2</sup>, and S. Brueckner<sup>1</sup>. <sup>1</sup>University of Tennessee Knoxville; <sup>2</sup>Indiana University

Switching between tasks often produces a clear decrement in performance. This decrement can be characterized as the cost of switching tasks. Switch costs have been well documented in categorical decision-making tasks in the verbal domain (Allport, Styles, & Hsieh, 1994; Jersild, 1927; Meiran, 1996; Rogers & Monsell, 1995). The basic switching protocol involves the comparison of reaction times for repeated and switched task conditions with the "cost" manifested as longer reaction time latencies or a greater number of



errors, or both. Switch costs have been demonstrated in the motor domain (Shea, Fairbrother, & Parry, 2003) by comparing a repeated schedule to a randomly alternating schedule. It remains to be determined whether those results were due to the act of switching between tasks or to the choice reaction time paradigm that was produced by using the random schedule. The purpose of the present experiment was to determine whether the switch cost for a simple motor task was dependent on unpredictability of the upcoming trial in the switched condition. Participants completed 15 pretraining trials followed by 15 trials of the primary task. They performed the tasks according to either a repeated schedule (Rep) or alternating with a second key-pressing task. The alternation of tasks was either predictable (e.g., ABAB...), for the alternating schedule (Alt), or unpredictable (e.g., ABAABA...), for the random schedule (Rnd). Results indicated significantly slower reaction time (RT) and total time (TT) for the Alt and Rnd schedules vs. the Rep schedule,  $p < .01$ . The Alt and Rnd schedules did not differ from one another. Thus it was concluded that the switch cost was not due to the unpredictability of the upcoming trial. This suggests that the source of the switch cost was related to the act of switching itself rather than to inadequate preparation for the upcoming task.

### **Contextual Diversity and Activity Theory in Sport Psychology: A New Approach**

Farres, L.G.<sup>1</sup>, and A.C. Muscat<sup>2</sup>. <sup>1</sup>New Westminster, BC; <sup>2</sup>Vancouver, BC

The goal of this study was to examine contextual diversity in sport psychology consulting settings. Understanding context in sport settings is emerging as a necessary step in successful sport psychology consulting (Brown, 2002; Gould, 2002; Muscat & Farres, 2003). Current perspectives, however, have approached context as a container or situationally embedded space to be analyzed and assessed as a separate entity. Activity theory (Engstrom, 1987, 1993; Leont'ed, 1974, 1981, 1989; Nardi, 1996) is presented as a more comprehensive framework for examining context in sport settings. Activity Theory approaches context as a dynamic activity system which includes the subjects (people) and objects (tasks) along with mediating factors (e.g., tools, resources, community, rules). The contradictions or tensions that exist in an activity system highlight problematic features in the consulting process that can be addressed and resolved. This framework is used as a lens through which to analyze a sport psychology consultant's experience at the Canada Winter Games 2003. Results indicated that contradictions in the context influenced the level of implementation of the sport psychology program (Fewster, Baldwin, Farres, & Muscat, 2003).

### **Examination of the Attentional Demands on Elite and Sub-Elite Netball Players in a Simulated Game Setting**

Farrow, D. Australian Institute of Sport, Canberra

Most team sports require players to simultaneously process multiple information sources while executing the skills of the game. Despite the prevalence of such situations, relatively little research has explored the dual-task capacities of elite and sub-elite athletes, particularly in an open skill context. This study reports on the validation of a dual-task test of netball passing performance in a simulated game setting. The purposes of the study were to determine (a) the attentional demands on netball players differing in skill proficiency, and (b) whether the same attentional load exists during the decision-making and skill execution phases of the task. Ten elite (National team members), 12 sub-elite (Australian Institute of Sport squad), and 8 club-level (B-grade domestic competition) netball players completed an interactive, video-based netball-passing task that measured their decision-making and passing accuracy in both single and dual-task conditions. A series of one- and two-way repeated-measures ANOVAs were completed separately for each performance mea-

sure. The elite and sub-elite players' performance was not only superior to that of the club level players but was also more resistant to skill decrement under dual-task conditions. Specifically, the elite and sub-elite players' decision-making accuracy was significantly better than that of the club-level players, while the elite players' passing accuracy was significantly better than either of the other two groups. The participants' vocal reaction times in response to the secondary task probe were significantly faster when presented during the decision-making phase of the players' response relative to the skill execution phase. Discussion centers on the allocation of attention during both the decision-making and skill execution processes, and the application of dual-task testing as a talent identification and training tool.

### **Longitudinal Models for Multivariate Analysis of Self-Worth, Competence, and Motivation**

Ferrer, E. University of California Davis

Alternative longitudinal models are presented to examine the interrelationships among physical self-worth, perceived athletic competence, and motivation over time in adolescents during their first semester in high school. Questionnaire data from students ( $N = 263$ ; mean age = 14.36,  $SD = .57$ ) are analyzed using a cross-lagged regression model, a latent growth model, and a dynamic model based on latent difference scores. The three models yielded different results and such differences are discussed in terms of the conceptualization of change underlying each model. The last model is defended as the most reasonable for these data because it captures the dynamic interrelationships among the examined constructs and, at the same time, identifies potential growth in the variables. Results from this approach indicate a bidirectional dynamic relationship between competence and self-worth, a unidirectional dynamic relationship from motivation to competence, and no relationship between self-worth and motivation over time.

### **A Qualitative Case Study of Young Women's Experience of Social Physique Anxiety**

Fleming, T-L.<sup>1</sup>, S. Junkin<sup>1</sup>, K. Kowalski<sup>1</sup>, L. Lebjak<sup>1</sup>, S. Martin<sup>1</sup>, D. Stevens<sup>2</sup>, and P. Crocker<sup>3</sup>. <sup>1</sup>University of Saskatchewan; <sup>2</sup>Brock University; <sup>3</sup>University of British Columbia

Body-related concerns are especially prevalent in young women and are heightened during adolescence. However, studies examining constructs such as social physique anxiety (SPA) have generally not highlighted the complexities of young women's experience, thus limiting our understanding of body issues. The purpose of this research was to utilize qualitative case study methods to better understand four young women's experience of social physique anxiety. Four phases were utilized. The first was a rapport-building phase in which multiple meeting times were organized with the participants in order to gain trust and build rapport. The second phase was a focus group meeting in which an art elicitation technique was used as a way for them to describe feelings about the body. Phases 3 and 4 were in-depth one-one-one semi-structured interviews and included personal interpretations of abstract photos. Results from the study highlighted the presence of several themes including conflicting feelings about the changing body, not knowing what other people are thinking, not knowing why they care about others' evaluations, the body as one aspect of appearance management, and resignation to concerns about the body. Trustworthiness of the data was supported through triangulation, member checking, peer debriefing, and rich description. This study illustrates the complex, dynamic process of the SPA experience of young women.

*Supported by Social Sciences and Humanities Research Council of Canada (SSHRC) and the Saskatchewan Health Research Foundation (SHRF)*

### **Cognitive and Motivational Functions of Imagery During Injury Rehabilitation and Their Relation to Practice Return Affect**

Fox, B. Columbia, SC.

The applied model of mental imagery (Martin, Moritz, & Hall, 1999) postulates that athletes can benefit from imagery use during the rehabilitation process and advocates identifying the imagery types most conducive to meeting the needs of injured athletes. One of these needs is to foster positive affect (i.e., confidence) upon return to practice. While studies have recently considered the cognitive and motivational functions of healing imagery content during rehabilitation (Sardoni, Hall, & Forewell, 2000), little is known about the continued use of sport-specific imagery content and its relation to affect upon return to practice. The purpose of this study was to examine imagery use during the initial phases of rehabilitation and subsequently, just prior to return to practice. Thirty-four Div. I college athletes ( $M = 19.6 \pm 5.1$ ) representing a variety of sports completed the SIQ (Hall, Mack, Paivio, & Hausenblas, 1998) upon sustaining an injury that precluded more than 8 days of participation, and again along with the SAS (Smith, Smoll, & Schultz, 1990), the day before return to practice. Contrary to what was expected, the functions of imagery remained constant throughout the rehabilitation. Actual length of rehabilitation was greater than had been estimated by the athletic trainer for 71% of the participants, and this difference was significantly related to concentration disruption. Athletes' perceived severity of injury was also a significant predictor of concentration disruption, accounting for 44% of the variance. These results suggest that sport-related imagery is overlooked during rehabilitation as a valuable component of the rehabilitation process. Practitioners should consider the use of imagery as a possible remedy for concentration disruption.

### **Age-Related Changes in Human Posture Control During Prolonged Standing**

Freitas, S., A. Barela, and M. Duarte. Sao Paulo, Brazil

In everyday life people are not constrained to stand "as still as possible." In natural standing, typically for a prolonged period, continuous low-amplitude and slow swaying of the body is commonly accompanied by postural changes characterized by fast and gross body movements. It is unknown whether a deficit in the postural control system would lead to a change in these responses and a consequent compromise in performance. In this study we characterized prolonged standing and its effect on postural control in older adults compared to younger adults. We estimated the postural changes by employing a stabilographic technique that identifies the patterns of center of pressure (COP) associated with the postural changes (Duarte & Zatsiorsky, 1999) and the area and speed of the COP sway. Eight adults and 14 elderly persons were tested during prolonged standing (30 min) and quiet stance conditions (60 sec). During prolonged standing they were allowed to make any movement without any constraint, staying within the limited area of the force plate while watching a TV documentary. The older adults showed a different behavior during prolonged standing: although the numbers of postural changes were about the same, the older adults produced postural changes of smaller amplitude and a decreased area of sway during the prolonged standing task. Both groups seemed to be equally affected by the prolonged standing task, as evidenced by their increased COP area and COP speed in the quiet standing trial after the prolonged standing task compared with the trial before. These results are a consequence of balance as well as mobility aspects.

### **Motor Ideation (Imagery) in Reaching: Does One Hemisphere Control an Advantage?**

Gabbard, C., and L. Rodrigues. Texas A&M University

The comparative study of imagined and actual movement provides an attractive approach in the quest to identify the specific aspects of cognitive and neuromotor processes and relationship. A common conclusion is that imagined and actual movements share common (overlapping) neurocognitive networks. Although this general hypothesis seems reasonable, there is a growing body of evidence that some networks may be at least partially distinct for the motor ideation and execution of the movement. For example, Johnson et al. (2001), using a limb-position reaching task with a single (commissurotomy) participant, concluded that the right hemisphere, corresponding to information in left visual field, is incapable of accurately representing (imagining) reaching movements involving either the contralateral or ipsilateral limbs. This hypothesis was examined in our study with strong right-handers who were asked to judge whether targets (lasting 150 ms) were reachable at randomly presented distances in three positions of hemispace: RVF, midline, and LVF. Responses were compared to actual maximum reaching distance. Results indicate that individuals are relatively accurate at imagining reachable distances in both visual fields, as well as midline. In summary, although a case of overlapping networks is plausible in the present context, these findings do not confirm the hypothesis of right hemisphere inability to represent reaching movements. Further discussion focuses on the experimental differences between participant and tasks used in this and the Johnson et al. study.

### **A Comparison of Jump-Landing Models From Developmental and Injury Prevention Perspectives**

Gagen, L., K. Haywood\*, and J. Onate. Old Dominion University; \*University of Missouri–St. Louis

Concern has grown over the increasing number of knee injuries to young athletes, especially those that occur from jump landings rather than collisions. Sport medicine specialists have begun to study the jump-landing mechanics associated with these knee injuries. Meanwhile, the interest of motor developmentalists in the flight and landing phase of jumping has waned over the last 15 years, since the jump takeoff appears to adequately represent jumping development. This study had two goals. First, conceptually, the developmental trends in jump flight and landing suggested years ago were compared to the newly identified features of “safe” jump landings. Second, empirically, a sample of 30 children was videotaped from front and side views during a jump landing to observe both developmental characteristics and safe landing components. The children ranged in age from 2 to 10. While a few markers of development were found to overlap safe landing components, many features of a safe landing appear not to be developmental in nature. Rather, it appears they are aspects of technique that should be taught and practiced. Younger children showed early landing patterns with a large amount of flexion at the hips, knees, and ankles, leading to a collapse into a roll to absorb the force of the landing. Older children showed less flexion and more balance during landings. A developmental sequence for a jump landing was hypothesized and compared with a sports medicine model for safe landing characteristics.

### **A Grounded Theory of Successful Partnerships in Beach Volleyball**

Galloway, S. Vancouver, BC

The objective of this study was to gain a deeper understanding of successful partnerships in beach volleyball. Two samples of  $n = 15$  athletes from the U.S. and  $n = 10$  athletes from Australia were interviewed via email; there were also  $n = 97$  information units col-

lected from *Volleyball* magazine focusing on professional players (1991–2003) as well as 4 in-depth interviews conducted. Grounded theory and content analysis was used to distinguish 6 main themes which could lead to an understanding of what makes a successful beach volleyball team. In order of importance, the following themes seemed to be relevant: (1) Complementing styles/skills; (2) Respect; (3) Similar perceived skill levels; (4) Stable personality; (5) Similar goals; and (6) Building up your partner. These findings were further supported by the in-depth interviews. Other results revealed an apparent perceived difference between the top professional national levels and all other levels with concerns to partnership dynamics. Friendship or the lack of friendship was cited most often as the main reason for this difference. Interestingly, it was found that friendship was one of the most important factors for top-level pro teams playing in the FIVB world tour. Differences between gender were also supported. The data revealed that most women were usually more humanistic in dealing with their partner. However, it was discovered that the top-level professional women and men are considered the same in how they deal with their partnerships. Implications for these findings related to established theories will be discussed in detail.

### **Psychological Response to Injury in Combat Sports: An International Perspective**

Galloway, S. Vancouver, BC

The objective of this study was to examine sources of psychosociological disturbances found in combat sport athletes from six continents with  $N = 391$  participants. Internet survey sampling was used to collect the data in accord with Szabo and Frankl (1996). The survey had both quantitative and open-ended qualitative items. Using content analysis, the results indicate that combat sport athletes: reacted negatively 26.1% to being injured; highly negatively 16.4% to being injured; both physically and psychologically negatively 15.6% to being injured; and redirected to positive mood 14.3% with regard to being injured. It was interesting to note that “missing social contact” only resulted in 3.3% of the responses given. Implications for the lack of social need as result of being injured, concerning combat sport athletes, will be discussed using Richman, Hardy, Rosenfeld, and Callanan’s social network theory (1989). Further discussion focuses on theoretical inference and practical applications for coaches and athletes involved in combat sports.

### **Predictors of Physical Activity Participation in Alberta**

Garcia Bengoechea, E., J. Spence, and K. McGannon\*. University of Alberta; \*University of Iowa

This study examined factors affecting physical activity levels among adults in Alberta. The survey included a random sample of 1,209 adults, 18 years of age and older, from the province of Alberta. The survey used a computer-assisted telephone interviewer system that randomly generated resident telephone numbers. Of the total number of valid households, 54% responded to the survey. Information was collected on demographics, current leisure-time physical activity (using questions adapted from the Godin Leisure-Time Exercise Questionnaire; Godin & Shephard, 1985), beliefs, attitudes, and perceptions of neighborhood. **Results:** In a hierarchical regression analysis, when a number of demographic, social-cognitive, and environmental correlates of physical activity were taken into consideration, the following were the only significant predictors of physical activity in this sample: (a) age ( $\beta = -.156$ ); (b) self-efficacy in overcoming barriers to physical activity ( $\beta = .335$ ); and (c) ease of access to places that allow physical activity ( $\beta = .105$ ). Self-efficacy in turn was related to gender, age, education, and annual household income. Ease of access to places that allow physical activity was influenced by gender, education, age, and provincial location. **Conclusions:** The circumstance that several factors of a demographic, social cogni-

tive, or environmental nature affect and/or independently predict physical activity in the present sample lends support for a determinants-of-health approach (e.g., Frankish, Milligan, & Reid, 1998). As the results of this study underscore, it is important to understand physical inactivity as a public health issue and not simply as a personal problem.

### **An Examination of Hostile and Instrumental Aggression in University Hockey**

Gee, C., and P. Sullivan. Brock University

It has been stated that we lack a reliable and comprehensive knowledge base concerning aggression in sport (Kirker, Tenenbaum, & Mattson, 2000). A possible reason for this shortcoming may be the limited methodological techniques previously used to assess this construct. Previous methodologies (e.g., self-report measures, archival records) have lacked ecological validity while concentrating on a small proportion of actual aggressive behavior. The present study attempted to validate previously published results by directly observing aggressive behavior during actual competitive events. Four Canadian interuniversity Sport (CIS) male hockey teams, competing at a neutral site, comprised the sample for this study. Three games were taped using a two-camera direct-observation design. Both cameras were time-coded so that information from both locations could be assessed simultaneously during data analysis. A total of 197 aggressive behaviors were coded according to an operational list and subsequently used to conduct statistical analyses. It was concluded that hostile and instrumental acts significantly differed according to the period of play,  $\chi^2(2, n = 190) = 10.61, p < .05$ , score differential,  $\chi^2(4, n = 197) = 16.20, p < .05$ , and whether or not a penalty was called,  $\chi^2(1, n = 197) = 6.03, p < .05$ . However, the behaviors did not differ according to player position, the winning status of the aggressor, or the aggressor's level of experience,  $p > .05$ . Several results run contrary to those previously published. Thus it appears there is a great need for this area of inquiry to be revisited using a more valid methodological approach.

### **The Development of Frequency, Stability, and Consistency in Single vs. Dual Motor Tasks**

Getchell, N. University of Delaware

As children develop, there is a trend toward increasingly stable and consistent performance of dual motor tasks within a self-determined frequency range (Getchell & Whittall, 2003). How does this compare to changes occurring in the same skills performed as single tasks? Sixty participants in 5 age groups (ages 4, 6, 8, 10, and adult; 12 per group) performed 3 trials each of 2 single tasks (clapping, walking) and a dual task (clapping while walking). Measures of frequency (mean across trials), stability (mean *SD* within trials) and consistency (mean *SD* across trials) were compared using  $5 \times 2 \times 2$  (Age  $\times$  Limbs  $\times$  Task) ANOVAs. Frequency results demonstrated significant main effects for age ( $F = 18.57, p \leq .0001$ ) and limb ( $F = 4.82, p < .029$ ), and a significant interaction between age and limbs ( $F = 2.79, p < .027$ ). Within-trial stability results indicated significant main effects for age ( $F = 10.79, p < .0001$ ), limb ( $F = 318.45, p < .0001$ ), and task ( $F = 4.92, p < .028$ ), and significant interactions between age and limb ( $F = 7.569, p < .0001$ ). Across-task consistency results indicated a significant main effect for age ( $F = 12.19, p < .0000$ ) and limb ( $F = 72.67, p < .0000$ ), as well as significant interactions between age and limb ( $F = 3.87, p < .0046$ ) and age and task ( $F = 2.63, p < .036$ ). Results suggest there is a limb-specific developmental trend toward decreasing frequency and increasing across trial consistency. There is a developmental trend toward increased within-trial stability that is both limb-specific and task-specific. Results are discussed in light of a dynamic pattern perspective.

*Supported by the University of Delaware Research Foundation*

### **Phase Error and Period Correction Processes in a Multi-Limb Task Performance: Adaptation to Tempo Changes**

Getchell, N., L. Glime, and M. Eichinger. University of Delaware

In movement tasks as varied as dancing and synchronized swimming, individuals must coordinate their limbs into specific timing relationships defined by an external auditory signal. If this signal is suddenly changed, how do they adapt to and resume synchronization with the signal? Ten participants were asked to simultaneously clap and walk to a metronome beat (e.g., 100% phasing between clap, step, and metronome) for 6 trials with no tempo changes and 6 trials with tempo perturbations (3 per speed). In the perturbation trials, the metronome speed randomly increased or decreased by 20 bpm midtrial. Phasing relationships (% of cycle where clap or step occurred) were measured between the clap/step, clap/metronome, and step/metronome for pre-perturbation cycles; phase error was calculated by subtracting the actual phasing relationship from the target relationship. Period correction values were calculated for cycles 1–5 after perturbation. Prior to perturbation there were significant phasing differences between the three phasing relationships,  $F(2, 150) = 14.1$ ;  $p < .0001$ . The clap/metronome (0.6) and step/clap (2.49) were more tightly coupled than the step/metronome (11.7). No differences were found based on direction of tempo perturbation. A two-way repeated measures ANOVA revealed a significant interaction between phasing relationship and cycle number in period correction in the post-perturbation cycles,  $F(4, 408) = 3.53$ ;  $p < .0006$ . The clap/metronome relationship showed the least phase error and the fastest period correction over 5 cycles. Only the clap/metronome re-entrained by the 5th post-perturbation cycle. These results suggest a clap-oriented control strategy of coupling and adaptation to beat change in this task. Compared to auditory adaptation experiments with finger tapping (e.g., Thaut, Miller, & Schauer, 1998), the adaptation ability of adults appears to be slower in this complex gross motor task.

*Supported by the University of Delaware Research Foundation*

### **A Test of the Transactional Process Model of Stress and Coping: Does Exercise Mediate Stress and Coping Reactions?**

Giacobbi, P., N. Frye\*, D. Tuccitto, and L. Martindale. University of Florida; \*C.W. Post Long Island University

The transactional process model of stress and coping has received considerable research attention. Originally developed by Lazarus and colleagues (Lazarus & Folkman, 1984), it predicts that cognitive appraisals (e.g., harm/threat, challenge, control) of specific situations are linked to one's emotional and coping responses. In general, the research supports the predictions of the transactional process model of stress and coping (Lazarus, 1999), but few studies have tested the tenets of this theory to assess whether exercise and physical activity are systematically related to cognition, emotion, and coping. Thus the present study tested aspects of this model and assessed relationships between leisure time exercise, cognitive appraisals of important life events, coping strategies, and mood. Three research questions were addressed: Is the relationship between cognitive appraisals of daily life events and mood mediated by leisure time exercise? Is the relationship between exercise and mood independently associated with that between cognitive appraisals and mood? Is the relationship between cognitive appraisals and coping mediated by exercise behavior? To help answer these questions, 55 undergraduate university students recorded daily information related to their most stressful events between 4 and 16 consecutive days ( $M = 11.40$ ,  $SD = 4.08$ ). They also completed ratings about how threatening, challenging, and controllable these situations were perceived, assessments of mood (PANAS; Watson, Clark, & Tellegen, 1988), leisure time exercise (LTEQ; Godin, Jobin, & Bouillon, 1986) and their coping responses (COPE; Carver, Scheier, & Weintraub, 1989). Hierarchical linear modeling (HLM; Bryk &

Raudenbush, 1992) confirmed the hypothesis that exercise was significantly and positively associated with increases in positive mood states. However, the lack of a significant interaction between exercise and cognitive appraisals of stressful life events suggests that exercise does not mediate the relationship between cognitive appraisals and positive mood states. A similar model that assessed the relationship between exercise, cognitive appraisals of daily life events, and negative mood revealed that exercise behavior was not significantly associated with reductions in negative mood. To answer the second research question, we computed a model that included cognitive appraisals of threat, control, challenge, and exercise behavior. If the relationship between mood and exercise is independent of that between mood and cognitive appraisals of daily events, then the relationship between mood/exercise would remain significant when added to the model. The results showed that even when threat, control, and challenge appraisals were included in the model, exercise was positively associated with increases in positive mood states. Conversely, a separate model using negative mood as the dependent variable did not reveal a significant relationship between exercise and decreased negative mood states when entered into the model. These results suggest that exercise is independently associated with changes in affect regardless of the types of events experienced on a given day. With regard to coping, the third research question assessed whether exercise behavior mediates the relationship between cognitive appraisals of daily events and coping behaviors. For this analysis, a factor analysis was run to group coping behaviors into higher order factors labeled as social support, mastery or problem-focused coping, and emotion-focused coping. The results revealed that increased daily levels of exercise did not mediate the relationship between cognitive appraisals of stress and coping behaviors. In summary, the results showed that exercise behavior is independently associated with increases in positive but not negative mood states. In contrast to our hypotheses, exercise did not mediate the relationship between cognitive appraisals of stress and mood, nor that between cognition and coping.

### **Manual and Spatial Asymmetries in the Use of Advance Information for Movement Planning**

Glazebrook, C., and D. Elliott. McMaster University

It has long been established that providing information about a subsequent movement leads to faster response times, and that certain types of information facilitate this reaction time advantage more than others, for example, specifying hand improves performance more than specifying the amplitude of the response. We wanted to determine whether precues would differentially influence the performance of movements made by the right or left hand, to the right or left, and to near or far targets. Twelve right-handed participants made rapid movements with their right or left hand to one of eight red buttons. Each trial began with the participant holding two home positions down with their right and left index fingers while the potential target buttons were illuminated for 1 second. The experimental design was 8 Precue Condition  $\times$  2 Hand  $\times$  2 Direction (right or left of the home position of that hand)  $\times$  2 Extent, blocked for precue. After a random foreperiod, the target was illuminated and participants responded with an aiming movement, using the appropriate hand. As expected, they were significantly slower to respond when none of the parameters were specified compared to when hand was specified. However, specifying direction or extent was not beneficial. Specifying hand and direction resulted in RTs that were no different than when hand, direction, and extent were all specified. There was also a main effect for direction, where movements to the left, whether executed with the left or right hand, were prepared faster. As well, a 3-way interaction between precue, hand, and direction revealed that movements to the left were prepared faster by the left hand in situations of greater uncertainty. The results of our study provide support for a fixed order of movement



preparation. As well, when movements are made in the right or left direction, the benefit of the precue changes depending on the hand and direction of the movement to be performed.

### **The Relationship Between Performance and Electromyogram Activity Associated With Imagery**

Glenn, J.M.<sup>1</sup>, and D. Landers<sup>2</sup>. <sup>1</sup>Phoenix, AZ; <sup>2</sup>Arizona State University

Previous studies have found elevated muscle activity of active arm biceps and triceps, but these studies did not relate this EMG activity to performance. This experiment replicated and extended the results of one such study (Slade et al., 2002) by examining EMG and performance on a coincident-timing task. Sixty participants, randomly assigned to a group that imagined the task (experimental) or one that imagined an unrelated beach scene (control), attempted to coincide the end of an arm curl on a manipulandum with the onset of a target lamp on a Bassin anticipation timer runway. EMG activity was collected for all participants during imagined as well as real arm curls. Performance timing (in ms) was measured in terms of deviations from the moving target. EMG activity during imagery was significantly higher at the biceps site of the experimental group when compared to control, and EMG activity during imagery was significantly elevated above baseline for both the biceps and triceps of the right arm of the experimental group. There was no significant difference in performance between groups, suggesting that the physical coordination required by the task may not have been significantly impacted by imagery. Results are discussed in relation to psychoneuromuscular (Richardson, 1967b), attentional-arousal set (Landers et al., 2000), functional equivalence (Jeannerod & Decety, 1995), and symbolic learning (Sackett, 1935) theories.

### **Visual Information and Body Sway Coupling Adaptation in Children and Old Participants**

Godoi, D., and J. Barela. UNESP, Sao Paulo, Brazil

This study examined the coupling between visual information and body sway in 4- to 14-year-old participants at different frequencies of the moving room and distances between the room frontal wall and the participants. Sixty children and 10 young adults were asked to maintain the upright stance inside a moving room that was oscillated back and forward at frequencies of 0.1, 0.2, 0.5, and 0.8 Hz at four distances away from the frontal wall: 25, 50, 100, and 150 cm. The coupling between visual information and body sway was analyzed through the variables coherence, gain, relative phase, and angular deviation. Visual information from a moving room induced body sway in all participants at all distances and frequencies. The coupling between visual information and body sway became stronger and more stable and the room movement influence became weaker with age in all conditions. In addition, until age 10 years this coupling became weaker and less stable and the room movement influence became weaker with the increase of distance. Regarding the frequency manipulation, the coupling strength between visual information and body sway was weaker in 10-year-old and younger children compared to older groups when the room was oscillated at 0.1 Hz. In addition, although the stability of coupling between visual information and body sway and the influence of room movement decreased in all groups, the same pattern was observed among the four frequencies. Based on these results, it may be suggested that 10-year-old and younger children are not able to accommodate to changes in sensory stimulus and have difficulty using information in a prospective fashion to control posture.

### **The Contextual Interference Effect in Older Adults**

Gonçalves, W., G. Lage, A. Silva, H. Ugrinowitsch, and R. Benda. Belo Horizonte, Brazil

The generalization of contextual interference effect (CIE) has been attempted in different experimental contexts and different learning and development levels. However, a few studies have verified the relationship between structure of practice and older adults. Forty eight participants, age  $66.4 \pm 4.8$  yrs, were randomly divided in 4 acquisition-retention test groups: random-blocked (RB); random-random (RR); blocked-blocked (BB); and blocked-random (BR). The groups practiced 45 trials of 3 tasks in the acquisition (different movement sequences), consisting of transporting 3 tennis balls between 6 containers in the same box in the target time of 3.5 sec. Two transfer tests (T1 and T2) with different complexities and target times (3.5 sec for T1; 4.5 sec for T2) and a retention test (R) were applied 3, 6, and 15 min after the end of the acquisition, respectively. In the analysis of absolute errors, the two-factor variance analysis (4 Groups  $\times$  7 Blocks) revealed significant Groups  $\times$  Blocks interaction among the last block of acquisition and test blocks,  $F(18, 264) = 1.68$ ,  $p = 0.042$ . Tukey's post hoc test indicated that the BR retention's first block was significantly poorer than the last block of acquisition in BR,  $p < 0.01$ , and RB performed with significantly smaller error than BR in R first block,  $p < 0.01$ . In the analysis of standard deviation of absolute errors, the two-factor variance analysis (4 Groups  $\times$  7 Blocks) revealed significant Groups  $\times$  Blocks interaction among the last block of acquisition and test blocks,  $F(18, 264) = 2.12$ ,  $p < 0.01$ . The post hoc test indicated that the retention first block performance was significantly more variable than the last block of acquisition in BR,  $p = 0.005$ . The results partially support the CIE prediction for older adults due to the fact that the blocked group (BB) showed less ability to perform in a novel practice context, while the random group (RB) showed greater flexibility.

### **Attenuation of Frontal Lobe Decline With Physical Activity: A Neuroimaging Study**

Goodman, R.N., R. Price, J.B. Zimmerman, H.S. Stover, S.P. Deeny, B. Wallace, W.R. Bixby\*, A.J. Haufler\*\*, and B.D. Hatfield. University of Maryland; \*Texas Tech University; \*\*McDaniel College

Elderly men and women exhibit a decline in executive processes, which are mediated by the frontal lobes. Kramer et al. (1999) provided behavioral evidence that physical activity preserves executive function. The purpose of the present study was to determine via neuroimaging (ERP) if physical activity is also associated with more efficient frontal lobe activation during executive challenge in older men and women. Specifically, participants were challenged with a go/no-go response inhibition task, while ERPs were derived from frontal sites (F3, F4, and FZ), to determine N2 amplitudes. N2 amplitudes have been shown to increase with age. For N2 amplitude we predicted that physical fitness would be positively correlated (decrease in negative amplitude) with weekly self-reported Kcal expenditure as assessed by the Yale Physical Activity Survey for Older Adults. As predicted, a significant relationship was found between activity and N2 amplitudes during the no-go task,  $F(2, 76) = 4.52$ ,  $p = .01$ , at sites F3 and FZ,  $F(2, 76) = 3.38$ ,  $p < .05$ . In conclusion this study provides evidence that physical activity does indeed preserve cortical function in the aging human brain. Physical activity appears to attenuate decline in a specific manner in those brain regions that are most susceptible to age-related decline, the frontal lobes.

**I Always Assumed That My Energy, My Mind, and My Body Would Match: Physical Activity Experiences of Women With Physical Disabilities**

Goodwin, D., and S. Compton. University of Saskatchewan

Relatively little research has addressed aging with a disability and the impact of physical activity on health and function. This hermeneutic phenomenological study originally asked 10 women with physical disabilities to share their stories about their bodies and how they described themselves, what they did during the week that they would term physical activity, and the meaning that physical activity held for them. By way of semi-structured audiotaped interviews, 6 of the 10 women spontaneously discussed their concerns, fears, and apprehensions about aging. This was surprising to us as researchers, as the mean age of the 10 women was 30 years (range 22–49 yrs). The verbatim transcripts of these 6 women were thematically analyzed around the question of aging and revealed three themes: experiencing something normal, loss of physical freedom, and maintaining function through physical activity. The themes represent the experiences of women with cerebral palsy ( $n = 2$ ), acquired brain injury ( $n = 1$ ), and spinal cord injury ( $n = 3$ ) between the ages of 22–37 years (mean age 28 yrs). Implications of the findings are discussed within the context of health promotion and Verbrugge and Jette's (1994) sociomedical model of disablement. The experiences of these 6 women have implications for health promotion and the advancement of active lifestyles for persons with disabilities.

*Supported by Health Science Utilization Research Commission of Saskatchewan, Canada*

**Skilled Performance in Baseball Batting: Understanding Successes and Failures**

Gray, R. Arizona State University East

With margins for error of a few milliseconds and fractions of an inch, it is not surprising that hitting a baseball is considered one of the most difficult acts in all sports. We examined this challenging behavior using a virtual baseball batting setup in which realistic 3D simulations of an approaching ball, pitcher, and field were combined with real-time recording of bat and limb movements. Experts, college baseball players, were able to use a variety of information sources including situational probabilities related to the pitch count and pitch sequence, the direction of ball rotation, and the arm speed of the simulated pitcher to increase spatial and temporal swing accuracy. These information sources had significantly less influence on the swing accuracy for novice batters. An extraneous dual-task condition that involved judging the frequency of an auditory tone presented during the swing revealed that this expertise effect most likely occurred because novices do not seem to have sufficient available attentional resources to simultaneously hit and attend to extraneous sensory information. A skill-focused dual-task condition that involved judging the direction of bat movement at the instant when an auditory tone was presented revealed that experts increase skill-focused attention during performance slumps (as indicated by an increase in the judgment accuracy of bat direction). This increase in skill-focused attention was associated with a significant increase in movement variability and a significant decrease in the effect of pitch count, pitch sequence, and pitcher arm speed on swing accuracy. These findings suggest that the attentional focus adopted by an athlete is a significant determinant of both (a) the difference in performance success of experts relative to novices and (b) periods of performance failure in experts. Implications for training will be discussed.

### **The Impact of Opponents' Nonverbal Behavior on the First Impressions and Outcome Expectations of Tennis Players**

Greenlees, I., R. Buscombe\*, and T. Holder. University College Chichester; \*South East Essex College

One aspect of social cognition that has received little research attention in sport psychology is the impact of nonverbal behavior on sporting encounters. The purpose of this study was to examine the effect that a tennis player's clothing and body language have on the way in which he/she is perceived by a potential opponent. Forty experienced male tennis players ( $M$  age = 31.2;  $SD$  = 4.7) viewed one of four videos of a male tennis player warming up for a tennis match. Each video portrayed the model in one of four combinations of body language (positive vs. negative) and clothing (sport-specific vs. general sportswear). After the video, participants gave their impressions of the model on a 10-item scale. They also completed a measure of their outcome expectations for a hypothetical encounter with the model. Analysis of variance revealed that models portraying positive body language received more favorable first-impression ratings than models displaying negative body language,  $p < .001$ . Clothing had no impact on first-impression ratings. A second ANOVA indicated that participants reported lower confidence in their ability to defeat the opponent when they viewed opponents portraying positive body language vs. negative body language,  $p < .001$ . No effects for clothing were observed. The study therefore provides support for the potential importance of nonverbal behavior in sport, and in particular highlights the role of body language in determining the first impressions that are created of opponents.

### **Examining the Efficacy of the Concentration Grid Exercise as a Concentration Enhancement Exercise**

Greenlees, I., R. Thelwell\*, and T. Holder. University College Chichester; \*University of Portsmouth

The purpose of this study was to examine the efficacy of Harris and Harris' (1984) concentration grid exercise, an exercise proposed to enhance concentration and visual scanning speed. A total of 28 male college soccer players were assigned to either a 9-week concentration grid training condition or a control condition. Concentration grid training consisted of 9 weekly meetings with an experienced sport psychologist and practice assignments in between sessions. During the first, fifth, and final weeks of the experiment, all participants completed a battery of concentration tasks (a visual search task, a video observation task, and a concentration grid). A series of MANOVAs and ANOVAs showed no significant interaction effects indicating that the concentration training group did not improve to a greater extent than the control group in any measure of concentration. These findings highlight the need for further research examining the efficacy of the concentration grid exercise using different training protocols and different dependent measures. In addition, the results also indicate support for sport psychologists who have urged caution with the use of the concentration grid exercise in applied sport psychology.

### **The Effect of Nicotine on Human Motor Control**

Guadagnoli, M., G. Stelmach\*, and T. Bargas. University of Nevada Las Vegas; \*Arizona State University

The negative effects of nicotine on health have been well documented in recent years. However, a less obvious effect of nicotine may be its acute effects on human motor control. The current study examined visuomotor adaptations as associated with nicotine intake. Ten smokeless tobacco (ST) users and 11 non-nicotine users volunteered as participants. The

task required them to use a pen for a point-to-point, horizontal arm movement to a target. Visual feedback (on a computer screen) of the pen-tip trajectory was manipulated during the task. The display of the visual feedback of hand movement was altered by rotating the direction of actual movement clockwise. Four movement directions were presented randomly: 45, 135, 225, and 315°. Participants were tested during baseline (normal visual feedback), distorted visual feedback (45° rotation), and baseline (normal feedback) conditions before ST intake, and then 15 and 45 min after ST intake for a total of 9 sessions. Control participants were also tested at the same corresponding time in the absence of ST intake. There were no differences in baseline performance among participants as a function of tobacco status or smokeless tobacco intake. However, during the altered visual feedback condition, the ST group produced more errors than the control group. Overall, these data suggest that smokeless tobacco users have altered motor execution during visuomotor adaptation.

### **Neuromuscular and Cognitive Factors Delay Responses in the Psychological Refractory Period Paradigm**

Guan, H., and H. Morris. Indiana University

The psychological refractory period (PRP) paradigm has been used to examine the delay in the response to the second of two sequentially presented stimuli when the inter-stimulus interval (ISI) is short (e.g., <500 ms). The literature on PRP has focused primarily on the possible cognitive factors for such a delay. The purpose of this study was to identify possible neurological as well as cognitive factors of reaction time delays in a PRP model. Eight volunteer right-hand-dominant participants were tested on each of 4 successive days for their visual reaction time (TRT) responses with supination and pronation movements of the forearms. In the PRP condition the stimuli were separated by ISIs that varied between 50 and 800 ms. TRTs were fractionated into premotor times (PMT) and motor times (MT) for each response using electromyographic recordings of the biceps brachii and pronator teres muscles. Data were screened for outliers and examined for trends, and reliability analyses were completed. Subsequently the data were analyzed using a factorial arrangement of treatments that included the direction of hand movements of each response and the ISIs. The TRT and PMT results had similar profiles including a significant interaction between the ISIs and responses to the two stimuli. The motor times were a function of an interaction between movement direction and the first and second responses. These results support the conclusion that neurological as well as cognitive factors determine the extent of delay of the second response in the PRP paradigm.

### **The Relationship Between Global Self-Worth, Sport Competence, Physical Appearance, Fitness, Fatness, and Physical Activity in Young Children: The MCG FitKid Project**

Gutin, B., J.B. Moore, and Z. Yin. Medical College of Georgia

The concept of self-worth has been extensively examined in adolescents and adults. Results have generally shown an inverse relationship between self-worth and fatness in women and a positive relationship between self-worth and fitness in males. Furthermore, the negative relationship between perceived attractiveness and body mass index (BMI) is most strongly observed among white females compared to white males, black females, and black males. Very little is known about these relationships in children. The purpose of the present study was to determine the relationship between self-worth, perceived attractiveness, athletic competence, fitness, BMI, and physical activity in a sample of 3rd grade students ( $N = 497$ ). The students (mean age =  $8.7 \pm .57$  yrs; 169 white, 328 black; 238 boys, 259 girls; 68% eligible for free/reduced school lunch) completed three subscales of the

Self-Perception Profile for Children: Global Self-Worth (GSW), Physical Appearance (AP), and Athletic Competence (AC); the Physical Activity Questionnaire for Children (PA), a step test to measure cardiovascular fitness (CVF), along with height and weight measurements. Controlling for age, boys reported higher AC than girls (2.94 vs. 2.72,  $p < .01$ ), but girls reported higher AP than boys (3.20 vs. 3.07,  $p < .05$ ). Black children reported higher AC than white children (2.91 vs. 2.75,  $p < .05$ ). Controlling for age, BMI was significantly correlated with GSW in white boys ( $r = -.37$ ,  $p < .001$ ), AC in black boys ( $r = -.18$ ,  $p < .05$ ), and AP in white boys ( $r = -.33$ ,  $p < .01$ ), white girls ( $r = -.24$ ,  $p < .05$ ), and black girls ( $r = -.25$ ,  $p = .001$ ). CVF was significantly correlated with GSW in white boys ( $r = .33$ ,  $p < .01$ ). PA was significantly correlated with AC in black boys ( $r = .24$ ,  $p < .01$ ) and black girls ( $r = .19$ ,  $p < .05$ ). These results would suggest that the relationships between global self-worth, physical self-perceptions, fitness, and fatness have begun to form by 7–10 years of age, similar to those seen in adolescents and adults.

### **Locus and Modulation of the Location Negative Priming Effect**

Guy, S., and E. Buckolz. University of Western Ontario

Responding to a current target event's location (probe trial) is lengthened when the target position has just been occupied by a distractor event (prime trial), relative to when it was earlier unoccupied (control trial). This latency difference constitutes the location negative priming (NP) effect. Early accounts of the NP effect held that the reaction time slowing, seen when responding to former distractor locations (ignored-repetition trial), resulted from an inhibited processing at the distractor location (location locus). More recent experimental evidence, however, points to the fact that it is the need to use the (just inhibited) prime-trial distractor response that causes the slowing on ignored-repetition trials (a response locus for the location NP effect). In this study we re-examined the possibility of a response locus for the location NP effect by cueing the response needed on the probe trial (cue validity = 75% or 100%), but not the target's location. The critical trials were those in which the prime-trial distractor response was cued for probe trial use. This amounted to telling participants that if the prime distractor response had inhibiting or interference effects dealing with its re-use, this effect should be removed. If participants can do this, we should see the removal or reduction of the location NP effect on valid response cue trials. This did occur; the location NP effect was significantly reduced or entirely removed when the cue validity was 75% and 100%, respectively. This supported a response locus for the location NP effect and the fact that inhibitory aspects of distractor (recently inhibited) responses can be modulated on the basis of the kind of information provided herein.

### **Do Exercise Preferences Predict Exercise Behavior?**

Hagan, A., and H. Hausenblas. University of Florida

Most Americans are either sedentary or low active, and thus do not receive the health benefits of regular exercise. Examining individuals' exercise preferences may help increase people's physical activity levels. The purpose of this study was to determine whether exercise preferences predict exercise behavior. Participants were 336 male and female undergraduates (mean age = 21.19,  $SD = 2.84$ ; 50.9% female) who voluntarily completed the Leisure-Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985) and the Preferences to Exercise Questionnaire (Hagan & Hausenblas, 2003). The preferences that were assessed included intensity level, rhythm of exercise, mode of exercise, time of day, number of days per week, whether the exercise is scheduled, exercise location, listening to music, instruction type, exercise company, and exercise duration. A response rate of 96% was obtained. Correlations were computed between the LTEQ and the exercise preferences that were on a visual analog scale. Any correlations that were significant were then used in

a multiple regression analysis with the preferences as the independent variable. Results revealed a significant regression,  $F(4, 324) = 20.80, p < .01$ , with days per week ( $\beta = .05, p < .01$ ) and how scheduled the exercise is ( $\beta = -.25, p < .01$ ) as being predictors of exercise. More specifically, the strongest predictor of exercise behavior is when individuals prefer to exercise 5 days a week and when the exercise is either extreme of scheduled or spontaneous. For exercise preferences on a dichotomous scale, an ANOVA was computed with exercise behavior as the dependent variable. Results revealed that only duration of exercise,  $F(3, 329) = 3.32, p = .02$ , was significant with 20–40 minutes a session indicating less exercise during the week than exercise done in a 40- to 60-min bout or a bout greater than 60 minutes. Implications and future directions are discussed.

### **Exogenous Orienting of Visual Attention in a Perceptual Training Program**

Hagemann, N., and B. Strauss. Westfaelische Wilhelms-Universitaet Münster

Efficient performance in racket sport depends on an early anticipation of the direction of the opponents' strokes. The event occlusion paradigm has been used to provide significant information about the most important areas of the movement pattern. Unfortunately, this paradigm does not emphasize the alteration during the stroke. Therefore a combination of the event occlusion (7 levels) and the temporal occlusion paradigm (4 levels) was used to determine the time course of the "information-rich" areas (Magill, 1998). First Division and Intermediate male badminton players ( $N = 43$ ) had to predict the stroke outcome of 112 video clips on a computer screen. Compared to the uncovered footage, the trunk contains most information for the stroke outcome up to 160 ms prior to ball contact,  $t(43) = 1.82, p < .05$ . The movement of the arm is most important up to 80 ms prior to ball contact,  $t(43) = 1.45, p = .08$ , and the racket contains the significant information prior to ball contact,  $t(43) = 3.57, p < .01$ . This information was used for a perceptual training program. A red transparent layer highlighted the information-rich area in 200 training clips. Novices ( $n = 23$ ) practiced with these video clips and were compared with a group watching the footages without the layer ( $n = 20$ ) and a control group ( $n = 20$ ). The  $3 \times 3$  (Group  $\times$  Block: pre, post, retention) repeated-measures ANOVA revealed a highly significant interaction,  $F(4, 120) = 5.40, p < .01, \eta^2 = .15$ . Furthermore, there was a significant interaction between the two training groups (post; retention),  $F(1, 41) = 5.21, p = .03, \eta^2 = .11$ , which indicates the advantage of the attentional guidance group. Exogenous orienting of visual attention (Posner, 1980) should therefore be considered to improve perceptual skills using video technology.

### **Visual Time-to-Contact in a Postural Task**

Haibach, P., S. Slovounov, E. Slobounova, and K. Newell. The Pennsylvania State University

This study looked at adults standing on compliant and noncompliant surfaces as a way to examine the control of posture under stable and less stable surface-of-support conditions. The study tested the hypothesis that virtual time-to-contact, which specifies the time to reach the stability boundary of each position of the center of pressure, given the dynamics of each sample point, is a variable controlled in the maintenance of upright posture. Three conditions of postural stability were used: no foam, 2 in. of foam, and 6 in. of foam. Three trials of each condition were performed both with and without vision available. A stability boundary trial was determined for each set of conditions whereby the participant was required to lean as far as possible in all directions without losing stability. As expected, the no-vision condition was found to have significantly higher displacement than vision for both COPx ( $7.7, p < .05$ ) and COPy ( $107.0478, p < .001$ ). Withdrawal of vision and increas-

ing depth of foam also increased the velocity of the center of pressure (107.0478,  $p < .001$ ). Virtual time to contact decreased as platform surface support became more compliant ( $p < .01$ ). The distribution of virtual time-to-contact showed properties similar to a power law over the range of virtual time-to-contact values. The findings imply that virtual time-to-contact in postural control operates as a fractal process and not a Gaussian distributional process, and lend support to the hypothesis that postural control is related to the stability boundary rather than preserving minimal motion around the center of the stability region.

### **The Effects of Acute Exercise Duration on Mood**

Hale, B.D., R. Lee-Kin Riedel, A. Sprow, and D. Russell. Penn State University–Berks

Hansen et al. (2001) reported that participants cycling 10 minutes at 60% of maximal heart rate showed significant improvements in mood (POMS, McNair et al., 1992) with no additional improvements from greater durations of exercise (20 and 30 min, respectively). In addition, ACSM guidelines (2000) suggest that 30 cumulative minutes of exercise a day may also improve health. This study sought to test whether shorter bouts of exercise would also produce similar levels of enhanced mood that have been reported for longer exercise bouts, and whether the improved affect lasts for 24 hours afterward. Thirty-six male and female participants were randomly assigned to three conditions: three 10-min exercise sessions, a 30-min exercise bout and two 10-min rest periods, and a control group that rested 10 min during all three sessions. The POMS was administered prior to exercise or rest during the first session, immediately after exercise or rest sessions, and approx. 24 hours after the first session. After initial repeated-measures ANOVA showed that pretest scores for the three groups were not matched, data were reanalyzed by subtracting the pretest POMS score from each POMS scale to create difference scores. Seven  $3 \times 4$  (Group  $\times$  Session) ANOVAs with repeated measures on the last factor were calculated. No significant differences were found for POMS total (TGMDS) scores for between- or within-subject comparisons. Significant main effects for group differences were computed for tension scores showing the 10-min exercise group lower in overall tension ratings, and significant within-subjects' main effects were calculated for fatigue scores indicating that these were higher 24 hours later than all other sessions. Results are discussed in terms of prior research findings, and suggestions are offered for improvements in design.

### **Gender Differences in Discrete Manual Aiming Under Visual Displacement**

Hansen, S., D. Elliott, and L. Tremblay\*. McMaster University; \*University of Toronto

This study examined the visual system's contribution to the control of upper limb movements, and the spatial and temporal limitations of the visual corrective process. A secondary purpose of the study was to examine gender differences in limb control following displacement of the visual field. In an initial experiment, a Fresnel prism and liquid crystal goggles were used to displace the visual field at the initiation of and during discrete manual aiming movements. In a second experiment the prism was presented prior to movement initiation, and then removed either at the beginning of or during the movements. In both experiments the participants were most influenced by the early presentation and removal of the prism. In the first experiment, a higher constant error in the direction of visual displacement indicated that female participants were significantly more affected by the manipulation. They spent more time deviating in the horizontal direction under visually displaced conditions, especially when the prism was presented at movement initiation. Given the results of the first experiment, the early removal of visual displacement was expected to



have a beneficial influence on the terminal accuracy of women. Regardless of gender, removal of the prism at movement initiation led to shorter movement times, with less time spent moving in the secondary axis of movement. As predicted, women were able to reduce their error to levels similar to those under undisplaced vision when the prism was removed at movement initiation. In contrast, men were significantly influenced by their exposure to the visual displacement, even when visual displacement was removed at movement initiation. It appears that women depend more on environmental context during the sensory-motor calibration processes implemented during manual aiming movements.

### **Nonlinear Analysis of Sitting Postural Control in Infants With and Without Movement Disorders**

Harbourne, R., N. Stergiou, I. Tscharnuter\*, and S. Dejong. University of Nebraska Medical Center; \*Tscharnuter Akademie for Movement Organization, Islip, NY

The purpose of this study was to examine changes in the center of pressure (COP) during three stages of normal sitting development in infants using nonlinear analysis methods, and then use this data to evaluate effects of physical therapy treatment in infants with movement disorders. Five normal infants were evaluated longitudinally from the age of 3 to 7 months. Three infants with movement disorders were evaluated pre- and posttreatment. COP data were collected using an AMTI force platform while infants sat quietly. The time series of COP data was analyzed via three nonlinear methods: The Lyapunov Exponent (LyE) estimated the stability of the neuromuscular system by measuring the rate at which similar trajectories in phase space diverged. Approximate Entropy (ApEn) estimated the complexity/regularity of the time series. Correlation Dimension (CoD) estimated movement dimensionality, or the degrees of freedom of the system. Repeated-measures ANOVA for the group of typically developing infants revealed significant differences between stages for LyE ( $p = 0.004$ ), CoD ( $p = 0.019$ ), and ApEn ( $p = 0.042$ ). LyE, CoD, and ApEn values for the treated children all moved toward values of infants with normal development from pre- to posttreatment. We conclude that infants develop a more stable strategy, a more periodic path, and increasing degrees of freedom that unfold to allow the emergence of independent sitting. Nonlinear analysis of COP time series in sitting may help measure increments of change in posture control, and help determine effective treatments for children with movement dysfunction.

### **Influence of Preparation Strategies on the Response Interference Effect in Children**

Hart, M.A., and T.G. Reeve. Texas Tech University

The response interference effect is demonstrated by slower reaction times (RT) when potential responses are from the same hand vs. from different hands (Kornblum, 1965). Although the different-hand advantage is a robust finding, manipulation of various factors (e.g., number of fingers in contact with response keys) results in changes in the RT pattern. One hypothesis for the different RT pattern is the preparation strategy adopted, which determines the presence or absence of response interference. Because children do not readily utilize explicit strategies in the same manner as adults, Hart and Reeve (2001) examined the response interference effect in children with two fingers in contact with response keys. They concluded that preparation strategies influence the presence of response interference. The purpose of the current study was to further examine the response interference effect in children when more than two fingers are in contact with the response keys. Three groups of participants, ages 5–6 years, 9–10 years, and college-age, completed a two-choice RT task using same-hand and different-hand conditions. The same-hand condition required them to respond with either the right middle or index finger, while the different-hand condition

required them to respond with either the right middle or the left index finger. Both hand conditions were performed under two finger conditions: 2 fingers and 4 fingers. For the 2-fingers condition, only the two fingers required to make a response were in contact with the response keys. For the 4-fingers condition, the middle and index fingers from both hands were in contact with response keys. The results of the data analyses ( $p < .05$ ) indicated different RT patterns for the 9- to 10-year-old group with regard to hand condition and number of fingers in contact with the response keys. These results support the hypothesis that the presence of response interference is due to the preparation strategy adopted.

### **Motor Learning and Performance Enhancement in Surgery**

Hauge, L. Rush University Medical Center, Chicago

Developing expertise in surgery has much in common with developing expertise in sport. Training in surgery, just as in sport, requires mental and physical excellence. Similarities between these domains include: decision-making in high stress environments, physical stamina, extensive concentration, team leadership, meeting high demands from leaders, and the need to continually develop and refine fine motor skills. Given these commonalities, there are extensive opportunities for motor learning and sport psychology researchers to contribute to the advancement of surgical education. This presentation provides examples of current interdisciplinary work and describes the needs and opportunities for future research, applications, and career options in surgery. Recent regulatory changes in surgical education have been the impetus for changing and improving surgical skill training. Surgical skill labs have become more commonplace. However, skill-training programs based on motor learning theories and principles are in their infancy. This presentation will describe how motor learning and performance enhancement theories and practices are applied in surgical residency programs. The culture in which surgeons perform, relevant to effective program planning and implementation, will be addressed. Current motor learning and performance enhancement research in surgery will be summarized, along with suggestions for future needs in research and faculty development. The application of motor learning and performance enhancement techniques to surgical training greatly benefits the growing discipline of surgical education. Researchers and educators from motor learning and sport psychology can be a valuable resource in meeting the training needs in the dynamic performance field of surgery.

### **The Relationship Between Coaching Efficacy and Coaching Burnout**

Haugen, C., S. Short, R. Brinkert, and M. Short. University of North Dakota

This study examined the relationship between coaching burnout and coaching efficacy. Based on previous theory and research in these areas, it was hypothesized that coaches who were higher in coaching efficacy would experience less burnout over the course of a competitive season compared to those lower in coaching efficacy. The sample was composed of high school basketball head coaches. For the preseason, 101 coaches participated; however, only 68 of them followed through by completing postseason measures. Coaching burnout was assessed using a modified version of Raedeke's (1997) athlete burnout measure. Coaching efficacy was measured with the Coaching Efficacy Scale (Feltz et al., 1999). Results showed that coaches had higher burnout scores at postseason. Coaching efficacy scores decreased from pre- to postseason. Correlations between burnout and coaching efficacy were negative at both time periods. Differences in coaching burnout were examined using a  $2 \times 2$  (High/ Low coaching efficacy group  $\times$  Pre/Postseason) MANOVA with repeated measures on the last factor. There were several significant main effects and interactions. In general, as time passed the low efficacy coaches were more burned out than the high efficacy coaches. It is likely that a combination of low efficacy in coaching abilities and high levels of burnout could result in coaches quitting their profession.

### **Influence of Response Associated Feedback on Movement Preparation**

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It is well known that informative precues about an impending response can reduce preparation time for that response. Kunde et al. (2002) have even presented evidence that certain actions, those which produce a particular effect, are automatically activated when that effect serves as a precue. In contrast, a noninformative precue about a target location can delay a response to that location if there is enough time for inhibitory processes to operate. This phenomenon is termed "inhibition of return" (IOR). While it has been shown that exogenous-auditory precues which sound at a target location can produce inhibition, centrally presented endogenous-auditory precues are less likely to elicit IOR effects. However, if Kunde et al. are correct in arguing that action effects are active during response selection, such endogenous-auditory precues may be expected to elicit IOR effects. In this study we examined these response processes in the context of a two-choice manual-aiming task. In an initial association phase, participants aimed at equally probable visual targets in left and right hemispace. For one group a specific tone sounded upon finger contact with each target. For a control group the tone-target pairing was random. In the second phase the same tones served as noninformative precues. The tone-target interval (SOA) was either 150 ms (insufficient time for inhibition) or 800 ms (sufficient time for inhibition). Contrary to our expectations, there was a general facilitation of both RT and total response time for the association group when the precue was followed by the target paired with the tone (i.e., valid precue). Moreover, RTs for the association group were longer in the 800-ms invalid condition than in all other situations. The fact that robust IOR effects were not observed when actions were cued by their effects suggests that action-effects are not governed by the same processes subserving responses toward exogenously specified targets. Rather it appears that, similar to situations of endogenous cueing, additional stimulus encoding procedures may be required, thus altering both the time course and strength of these effects.

### **Memory-Guided Reaching in Peripersonal Space: No Evidence for Real-Time Sensorimotor Transformations**

Heath, M. Indiana University

Recent work (e.g., Heath & Westwood, 2004) has suggested that online visual input from a moving limb is sufficient to engage memory-based target information for the real-time control of a video-based reaching task. The present study sought to extend that hypothesis to the control of memory-guided reaching movements in peripersonal space. Participants reached to touch a virtual target that was: (a) visible during the response; (b) extinguished at movement onset; or (c) extinguished for various intervals prior to response cueing (0, 500, 1500 and 2500 ms of delay). Target viewing conditions were factorially arranged with a condition in which online monitoring of a virtual limb was either available or unavailable during the response. To infer limb control (i.e., feedback vs. feedforward), we implemented a regression technique to examine the within-trial correspondence between the spatial position of the limb at various points in the reaching trajectory and the ultimate movement endpoint. A high degree of within-trial correspondence would suggest a feedforward mode of control; conversely, a low degree of within-trial correspondence would suggest a feedback-based mode of control. The results indicated that reaches performed in the absence of online limb and/or target information were specified largely in advance of movement onset. Only the condition permitting real-time limb and target viewing provided evidence of a primarily feedback-based mode of control. Therefore, and counter to the hypothesis above, the present results suggest that the normally online operation of the visuomotor system requires dynamic visual input from limb and target when reaching in peripersonal space.

### **Motor Representation and Kinematical Parameter in Complex Movement**

Heinen, T., F. Mechsner\*, and T. Schack. German Sportuniversity Cologne; \*Max Planck Institute Munich

In this study we aimed to start a systematic search for paths regarding biomechanical aspects and functional units of complex movements. A new experimental method was developed to measure the structure of mental representations in long-term memory (Schack, 2002). Concerning the analysis of kinematics, we developed a system for computer-based 3D analysis. Altogether we examined 5 groups with 7 subjects in each group ( $N = 35$ ) with an increasing ability to perform a twisting somersault. The results of the experimental analysis show that representational frameworks were organized in a hierarchical tree-like structure and matched the biomechanical demands of the task well. We found significant correlations,  $p < .00$ , between kinematic parameters of the movement and the accessory parts of motor representations. These results support the hypothesis that voluntary movements are planned, executed, and stored in memory directly via representation of their anticipated perceptual effects.

### **Collective Efficacy as a Mediator of the Cohesion-Performance Relationship in Professional Basketball Teams**

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This study examined whether collective efficacy was a mediator in the cohesion-performance relationship in French professional basketball teams. A total of 154 French ( $n = 105$ ) and foreign ( $n = 49$ ) professional players (mean age 26.2 yrs,  $SD = 4.5$ ) from 17 teams volunteered to participate in the study. The Questionnaire sur l'Ambiance du Groupe (Heuzé & Fontayne, 2002), for French players, and the Group Environment Questionnaire (Carron, Widmeyer, & Brawley, 1985), for foreign athletes, were used to assess four dimensions of cohesion: Individual attractions to group-task; Individual attractions to group-social; Group integration-task; Group integration-social. Following Bandura's (1986) recommendations, a 27-item measure (presented in both French and English) designed to assess both offensive and defensive collective efficacy was constructed. Two composite measures of individual performance were used (pre- and postperformance). Since French and foreign athletes were given two different questionnaires (French vs. English version) and had different playing times, which are related to individual performances ( $r = .88$ ,  $p < .001$ ), nationality and playing time were statistically controlled for. A set of multiple regression analyses was performed with playing time and nationality as independent variables, while cohesion, collective efficacy, and performance served as dependent variables. Residuals were used as new data for the subsequent analyses performed at the individual and group level. Following Baron and Kenny's (1986) suggestions, a set of simple and multiple linear regression analyses was undertaken and four conditions were examined. Results only supported the mediating effect of collective efficacy in the Preperformance/ Group integration/ Task relationship at an individual level. Results and implications are discussed.

### **Physical Activity Self-Definitions: Comparing the Weights of the Predictors Across Different Physical Activities**

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According to a model of physical activity self-definition, it is theorized that perceived commitment, perceived ability, and self-prototype match are the immediate antecedents of physical activity self-definition. Recent research on the model, however, has shown

that only perceived commitment and self-prototype match uniquely contribute to the prediction of runner/jogger self-definition. The present study tested the hypothesis that perceived ability would uniquely predict physical activity self-definition if the activity in question required more skill than running/jogging. Participants who played soccer, an activity that is perceived to require more skill than running/jogging, filled out surveys that assessed soccer player self-definition, as well as the three predictor variables. A hierarchical multiple regression analysis revealed that all three predictor variables, including perceived ability, uniquely predicted soccer player self-definition. Additional analyses revealed that there was a higher correlation between perceived ability and physical activity self-definition, as well as between perceived ability and self-prototype match, for soccer players compared to runners/joggers. Although running/jogging and soccer differ in ways other than the amount of skill required, these results support the idea that perceived ability becomes more important in predicting physical activity self-definition when the activity requires a higher level of skill.

### **Visual Estimation of Spatial Requirements for Locomotion in Novice Wheelchair Users**

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Locomotion using a wheelchair requires a wider space than walking. Two experiments were used to test the ability of nonhandicapped adults who had no prior experience in wheelchair use to estimate their extended spatial requirements when operating a wheelchair. Participants judged from a distance whether door-like apertures of various widths would be passable or not. Experiment 1 showed that they underestimated their extended spatial requirements but overestimated their spatial requirements for walking. Experiment 2 showed that their underestimation had improved but had not been completely eliminated after 8 days of practice in passing through apertures. Analyses of wheelchair performance in the practice showed that the underestimation may have stemmed from misperceiving the locations of the hands when grasping the wheelchair hand-rims. The theoretical and practical implications of these findings are discussed.

### **Testing Notions of Automaticity Through Attentional-Focus Manipulations**

Hodges, N.J., P. Ford, and A.M. Williams. Liverpool John Moores University

It has been shown that focusing attention on the step-by-step control of a skill is detrimental to performance for experts, but not for novices. These results are not in accordance with locus of attention effects. However, in previous studies the locus of attention has not been separated from the skill-relevant nature of attentional focus. In this study, 10 high-skill and 10 low-skill soccer players dribbled a ball using the dominant and nondominant foot after receiving instructions directing their attention to an internal skill-relevant (foot) or an internal nonskill-relevant (arm) feature. Two control conditions were employed: no attentional focus and auditory word-monitoring. For the high-skill performers using their dominant foot, an internal focus of attention was detrimental to performance compared to control conditions, regardless of the skill-relevant nature of the focus,  $p < .05$ . This result shows that expert performance is generally not attention-demanding and is likely characterized by an attentional focus that is externally-oriented rather than internally-oriented to the body. For the low-skill performers, an internal and yet skill-relevant focus of attention (foot) did not degrade performance relative to the no-attentional focus control condition, whereas both nonskill relevant conditions had detrimental effects,  $p < .05$ . The dribbling task was therefore attention-demanding for the low-skill players and characterized by an internal

focus of attention toward the foot. For the high-skill performers using their nondominant foot, a decrement in performance was observed under all three attention conditions. This result suggests that dribbling was attention-demanding, but different for novice performance in that both internal-focus conditions, regardless of their skill relevance, were detrimental to performance. It was concluded that an internal focus of attention is only detrimental to performance when it is not relevant to the skill (i.e., the end-effector) and when it interferes with a normally adopted attention strategy.

### **Reaching Errors Are Not Always Larger in Darkness During a Step-and-Reach Task**

Hondzinski, J., and Y. Cui. Louisiana State University

It has been shown repeatedly that persons pointing to a remembered target have greater errors than when pointing to a real target. Lighting conditions can also influence the accuracy of reaching, and reaching errors commonly increase when the seated person must reach in complete darkness vs. in a well-lit room. This suggests that, when available, individuals will use allocentric cues to improve their reaching performance. Although the largest errors for seated persons are generally in the anterior/posterior direction, we have found large reaching errors in the vertical direction that were dependent on target location when participants stepped and reached to targets in dim lighting. Because of these error direction discrepancies for the seated and standing and stepping participants, we wanted to determine the influence of environmental cues on reaching errors for the step-and-reach task. Therefore we monitored gaze direction and the tip of a hand-held pen while participants stepped and reached to real and remembered targets with (Light) and without (Dark) allocentric cues available. Targets, initially located at three heights (109, 147, and 164 cm) at a 95-cm distance, were removed from sight just prior to participant movement in remembered target conditions. Final horizontal and vertical gaze direction errors and x, y, and z pen position errors were calculated. To determine whether final reach was influenced by available allocentric cues, we compared errors in pen location for the Light and Dark conditions. Results revealed that when gaze was directed toward the remembered target location in a well-lit environment, participants reached further and above reaches in complete darkness, even though reaches were not always largest in the dark. We conclude that control strategies for reaches to remembered targets in the step-and-reach task depend on the available environmental cues and likely differ from strategies used by the seated individual.

### **Effects of a Sensorimotor Intervention on the Fine Motor Development of Infants**

Howard, C.\*, M. Rudisill, M. McAlister, and R. McAlister. \*Troy State University; Auburn University

This study examined the influence of a sensorimotor intervention on the fine motor development of infants ( $N = 32$ ) environmentally at risk of developmental delays and who represented Phase 1 (i.e., 12 weeks) and Phase 2 (i.e., 24 weeks) of prehensile development. Sixteen infants, 8 boys and 8 girls, represented Phase 1 of prehensile development, while another 8 boys and 8 girls represented Phase 2. Eight of the 16 participants from Phase 1 and Phase 2 of prehensile development were randomly assigned to participate in the intervention. The remaining 8 infants from Phase 1 and Phase 2 were used as a control group. Infants who received the sensorimotor intervention were provided eighteen 12-min sessions in which 6 sensory properties were introduced. The Posture and Fine Motor Assessment for Infants (PFMAI-I) was used as a pre- and posttest for all infants to measure fine motor development. The General Outcome Measure (GOM) was used as a pre- and posttest, and was also administered once a week (4 additional times) to monitor sensory motor de-

velopment. A  $2 \times 2 \times 2$  (Intervention Groups  $\times$  Prehensile Groups  $\times$  Time) ANOVA with repeated measures on the last factor revealed that for the pre-PFMAI-I, the Intervention and Control groups did not differ significantly from each other, but significant differences were found between the groups for the post-PFMAI-I. A  $2 \times 2 \times 6$  (Intervention Groups  $\times$  Prehensile Groups  $\times$  Time) ANOVA with repeated measures on the last factor revealed significant differences between the Intervention and Control groups for the GOM-Weeks 1, 2, 3, 4, and GOM-Post, but not for the GOM-Pre. The comparisons within groups showed that the Intervention group improved significantly each time the GOM was administered. No significant changes were found in GOM scores for the Control group. These findings suggest that exposing infants as young as 12 weeks of age to objects with various sensory properties can have a positive impact on their fine motor and sensory motor abilities.

### **Transitional Experiences of Elite Team Sport Athletes**

Howe, B.<sup>1</sup>, and V. Planella<sup>2</sup>. <sup>1</sup>Univ. of Victoria; <sup>2</sup>National Sport Center, Victoria, BC

Four volunteer female and four male team athletes, who had competed for Canada in international competition, were interviewed to examine their responses to the transitional experiences from the competition. They were selected to be representative of the four primary reasons for retirement: personal choice, age, injury, and deselection. The athletes had stopped competing internationally for an average of 6 years prior to the interviews. The objective was to determine the conditions and characteristics associated with the stages of the transitional process including sources of stress, personal resources, and coping strategies. Data were collected from extensive individual interviews and the responses were analyzed through the QSR NUD.IST program. While many of the findings were supportive of previous work in the field, it was clear that none of the athletes' responses were identical and that all experienced both positive and negative effects. Most positive results were found for those who felt they had more personal control in the decision, had more social support, and had managed to prepare for the experience. Regardless of their individual response to the retirement, all athletes considered that the benefits of participation outweighed the negative effects and they would have repeated the experiences given the opportunity.

### **Athletic and Exercise Identities: A Two-in-One Concept in Taiwanese Perspective**

Hsieh, P-S., C-M. Liao, S-W. Cheng, and S-Y. Chen. National Taiwan College of Physical Education

Two identity-related concepts, namely athletic identity and exercise identity, have been associated with behaviors in physical activity domain by researchers. Brewer and colleagues (1993) argued that a strong athletic identity may influence an individual's adaptive behaviors in sport in both positive and negative ways. Anderson's research (1994, 1995, 1998, 2001) showed that exercise identity may have predictive value for exercise behavior. It has been suggested in the literature, however, that a further examination with more items included in the measurement and more samples from different cultural backgrounds is needed. In addition, in a culture in which the concepts of athletic (sport) and exercise are ambiguous and difficult to separate (e.g., Taiwanese/Chinese), athletic and exercise identities may be of the same concept. This study examined the structure of athletic and exercise identities with a sample from a Taiwanese/Chinese cultural background. Chinese versions of both the Athletic Identity Measurement Scale and the Exercise Identity Scale were administered to 200 adults. In the first stage of data analysis, factor analyses revealed that both athletic and exercise identities are one-dimensional in structure and these two concepts are strongly associated ( $r = .92, p < .001$ ). In the second stage of analysis, items from both scales were combined and new items were added for a more comprehensive analysis. Factor analysis

showed a 4-factor solution: positive affect, exclusivity/negative affect, athlete identity, and importance. It seems that for Taiwanese/Chinese, the meanings of athletic and exercise identities are much the same. Their meanings are interpreted differently only when referred to sport competition or performance evaluation (i.e., athlete identity). Additionally, social identity, a component of athletic identity in Western samples, was not separated out in this sample. It is possible that in Taiwanese/Chinese culture, social identity is internalized into other aspects of self-identity.

### **Dimensional Complexity and Dart Throw Performance**

Huang, C-H., L-C. Lo, J-H. Lin, C-W. Chang, C-T. Wu, S-C. Lin, and T-M. Hung. Taipei, Taiwan

Previous study on EEG dimensional complexity during dart throw has failed to find differences between good and poor performance. We attributed this inability of nonlinear analysis of EEG to discriminate performance to the skill level of the participants. As sport psychologists suggest that psychological factors play a more important role in the development of skills, the fine-tuning of mental processes underlying superior sport performance can have an effect only on those who have reached certain skill levels. In the same vein, it is more appropriate to test the discriminative ability of nonlinear analysis of EEG on elite performers. As such, the purpose of this study was to examine the dynamics of cortical activity underlying the EEG signal between good and poor dart throw in highly skilled dart throwers. Ten elite dart throwers were recruited to perform 60 dart throws that were grouped into 5 blocks, 12 darts each, on a standardized dart throw task. Good performance in this study was indicated by trials that represent the center-of-mass dart throw score as being higher than the mean, while poor performance included those trials with unusually low scores. EEG was recorded at 5 electrode sites: Fz, Cz, T3, T4, and Pz. Eye movements were monitored using two bipolar arranged channels. In addition, two EMG electrodes were measured at a site one-third of the distance between the wrist and shoulder to mark the onset of the throwing movement. The recorded EEG of the last 2 seconds prior to the initiation of movement were segmented. Cleaned EEG epoch was analyzed using Dataplore software to compute the dimension. A  $2 \times 5$  (Performance  $\times$  Site) ANOVA with repeated measures on both factors was employed. Overall, there was no difference on dimension between good and poor performance. Due to the relative paucity of this line of research, more studies are needed to examine the effectiveness of nonlinear approach in EEG and sport performance.

### **Effect of Physical Activity on Cognitive Performance in Preschoolers: An Event-Related Potentials Study**

Huang, Y-C., J-H. Lin, F-J. Kuo, S-C. Lin, C-L. Li, and T-M. Hung. Taipei, Taiwan

The beneficial effect of physical activity on cognitive and emotional function has been widely documented. However, researchers in this area have focused mainly on clinical and nonclinical adults. Little is known about whether these effect can generalize to children. The purpose of this study was to examine the relationship between physical activity and cognitive performance of preschool children by the event-related potentials (ERPs). Participants were healthy children, 16 boys and 16 girls, ages 4–6. They were evenly assigned to either a control group or an experimental group. After 9 weeks of physical activity we compared the reaction time (RT), reaction time variance (RTV), reaction time error (RTE), and N1, N2, P3 of ERPs between the two groups. Both *t*-test and analysis of covariance (ANCOVA) were used to analyze these data. The results revealed that: (1) There was no difference on RT and RTE between these two groups. However, the experimental group had higher RTV than the control group. (2) From the ERP amplitude, we found that the experimental group had more efficient attention resource distribution than the control group.



(3) From the ERP latency, we found that the experimental group spent less time in decision-making for the discrimination task. The implication of these findings is discussed in the context of physical activity and efficiency of cognitive processing.

### **Development of Postural Control in Children With Down Syndrome and Those With Other Forms of Mental Retardation**

Huh, J., and C. Lee. Dankook University

One of the most frequently cited weaknesses of individuals with mental retardation including Down Syndrome (DS) is lack of dynamic balance. The problem in using classical tasks to analyze balance ability or postural control in persons with mental retardation (MR) including DS is related to sensory integration, which is a critical factor in postural control. There is a need to look further into the sensory factors affecting postural control in persons with MR. Thus the purpose of this study was to examine age-related changes in postural control of students with DS and other forms of MR using computerized dynamic posturography. A total of 90 children took part in the study: 30 DS, 30 MR, and 30 Control children. There were three age groups: ages 8–9 years, 13 yrs, and 18+ yrs. Selection was based on three criteria: (a) mild mental retardation (mean IQ from 58); (b) no physical disability; and (c) no uncorrected auditory or visual disability. The protocol consisted of the Sensory Organization Test, which assesses the three sensory components of balance under a variety of altered visual and support surface conditions, and the Motor Control Test, which evaluates the automatic motor reactions provoked by unexpected support surface perturbations. Results indicated that for the sensory organization test, composite equilibrium score, equilibrium scores for somatosensory and vestibular, vestibular ratio, and COG alignment in the DS group were lower than in the MR group. Both groups had lower scores in all tests than the Control group. No age-related pattern was found in children with DS or MR. For the motor control test, variability of latency in both groups was higher than that of the Control group. Age-related improvements of children with DS in postural stability were not uniform and depended on the specific sensory condition. Overall, these results indicate that poor equilibrium and inappropriate postural response of DS and MR groups may be related to using inappropriate visual information, cognitive factors of attention, and strategies of postural control.

### **Effect of Skill Level on EEG Alpha Power During Dart Throw**

Hung, T-M., J-H. Lin, L-C. Lo, Y-J. Chen, and S-C. Lin. Taipei, Taiwan

Psychophysiological studies on optimal mental states associated with skilled motor performance have suggested that efficiency of neural resource allocation is characteristic of optimal mental states. The development of neural efficiency as a result of adaptation to environmental demands can be revealed by measuring EEG. Although different brain regions serve different functions underlying skilled motor performance, previous studies have focused mainly on temporal asymmetry. Regions such as the frontal, central, and parietal area that are related to either attention or motor processing are mostly left unexplored. Thus the purpose of this study was to compare the cortical activity underlying the EEG signal on different brain regions between elite and intermediate dart throwers. Seventeen elite and 15 intermediate dart throwers were recruited to perform 60 dart throws that were grouped into 5 blocks, 12 darts each, on a standardized dart throw task. EEG was recorded at 5 electrode sites: Fz, Cz, T3, T4, and Pz. Eye movements were monitored using two bipolar-arranged channels. In addition, two EMG electrodes were measured at a site one-third of the distance between the wrist and shoulder to mark the onset of the throwing movement. The recorded EEG was segmented into four 0.5-sec epochs of the last 2 seconds prior to the initiation of movement. Cleaned EEG epoch were fast-Fourier-transformed to derive  $\alpha$  power. A  $2 \times 4$

$\times 5$  (Group  $\times$  Time  $\times$  Sites) ANOVA with repeated measure on the last two factors was employed. The results showed significant Group, Time, and Site main effect. The Group  $\times$  Time and Group  $\times$  Site interaction effects were also significant. As the main purpose of this study was to understand how skill levels affect EEG at different brain regions, follow-up analysis revealed that intermediate skilled dart throwers have higher  $\alpha$  power at all sites except T3. Additionally, elite dart throwers showed an equal  $\alpha$  power between T3 and T4, while intermediate skilled dart thrower had higher  $\alpha$  power at T4 than T3. This is a pattern consistent with past studies. The differences at the frontal, central, and parietal regions between these two groups should be further explored to provide more information on understanding the mechanism of optimal mental states.

### **Locomotion-Respiration Coupling: An Account of the Underlying Dynamics**

Huys, R., A. Daffertshofer, and P. Beek. Amsterdam, The Netherlands

We submit that a single physiological quantity, oxygen concentration in the lungs, may explain locomotion-respiration synchronization. Superposition of movement-induced abdominal pressure and respiratory oscillations results in (local) maxima at integer frequency ratios in effective oxygen concentration. The optimization of the effective oxygen concentration causes synchronization between respiration and rhythmic movement by varying the respiration frequency and/or phase. We modeled this dynamical adaptation in terms of two coupled self-sustaining limit cycle oscillators: cyclic respiration and periodic movement. The model exhibits various empirically observed steady synchronization phenomena and allows for switches between entrainment modes. For the latter, the amplitude and phase relationships between respiration and movement serve as bifurcation parameters. Hence, in searching for an optimal energy transfer, the intrinsic structure of lung pressure modulation may lead to spontaneous switches to other (sub)optimal synchronization patterns because integer ratios always reflect (local) maxima of the effective oxygen concentration.

### **Testing Theory of Deliberate Practice Relevance, Effort, and Inherent Enjoyment Postulates With a Novel Task**

Hyllegard, R., and M. Yamamoto. Western Illinois University

This study examined three theory-of-deliberate-practice postulates when learning a novel task: (a) that deliberate practice is relevant for improving performance; (b) that deliberate practice requires effort; and (c) that deliberate practice is not inherently enjoyable. Thirty participants completed 60 practice trials (3 blocks of 20 trials over 3 consecutive days) consisting of memorizing and reproducing a 23-segment maze pattern, followed by a retention test 2 days later. The maze was presented visually for 1.5 sec and was followed by a 30-sec reproduction interval when the participants reproduced the maze on graph paper. Following each practice block, practice relevance, effort, and inherent enjoyment were each rated on a scale of 0 (low) to 10 (high) points. A two-way ANOVA for the type of rating (relevance, effort, inherent enjoyment) by practice block (Block 1, Block 2, Block 3) revealed a Type  $\times$  Block interaction,  $F(4, 174) = 4.82, p < .01$ , for the practice ratings. The source of the interaction was between the effort ratings, which decreased across practice blocks, and the relevance ratings which remained consistent across practice blocks. Analysis of simple effects also showed that the mean inherent enjoyment ratings were lower than the mean relevance and effort ratings for each block of practice. Findings from the novel task supported all three theories of deliberate practice postulates, and also suggested that while learners perceive deliberate practice to be relevant and effortful, but not inherently enjoyable, some of these perceptions may change with experience.

### **The Effects of Average Feedback Length and Movement Complexity on Acquisition and Retention of Timing Movement**

Ishikura, T. Doshisha University

This experiment examined the effects of average feedback length and movement complexity on acquisition and retention of timing movement patterns. A barrier knockdown task was used, and all participants (30 M, 30 F) attempted to press a goal button in 1200 msec after pressing a start button. The participants were divided into one of six conditions ( $2 \times 3$ ): Movement complexity (simple task/complex task)  $\times$  Feedback length (100% KR/average of 3 trials/average of 5 trials). The simple and complex tasks required each participant to knock down one or three barriers before pressing a goal button, respectively. After a pretest without KR, participants practiced 60 trials of timing movement patterns with one of the three following conditions as a practice phase: KR after every trial (100% KR); average KR after every 3rd trial (Average 3); average KR after every 5th trial (Average 5). Participants then performed a posttest with no-KR and two retention tests without KR. The 1st retention test was taken 10 min after the posttest. The 2nd retention test was taken 24 hours after the posttest. Results were: (1) In the complex task, the absolute constant error ( $|CE|$ ) and the variable error (VE) were less when compared to the simple task. (2) The  $|CE|$  and VE of 100% KR and Average 3 were less than that of Average 5 in the practice phase, and the VE of 100% KR and Average 3 were less than that of Average 5 in the retention tests. (3) In the practice phase, the  $|CE|$  and VE of Blocks 1 and 2 were more than Blocks 5 and 6. (4) In the retention tests, the  $|CE|$  of the posttest was less than the first and second retention tests. And, the VE of 100% KR and Average 3 were less than Average 5 in the first and second retention tests. These results suggest that the average of three trials and KR after every trial tended to be an appropriate length for the practice of timing movement patterns.

### **The Impact of Training on Neuromuscular Patterns in Children's Pedaling**

Jensen, J.L., and P. Chao. University of Texas at Austin

This study probed the idea of developmental readiness and tested the hypothesis that experience is the dominant modifier of neuromuscular patterns in children. Participants included 9 children ages 4–10 yrs who participated in 3 training sessions of pedaling a stationary cycle ergometer. Pretests, training, and posttests were all conducted within a span of 3 weeks. Muscle onsets from 4 lower extremity muscles were correlated with pedaling cadence. In skilled adult cyclists, muscle onsets are highly correlated with cadence (Neptune & Herzog, 2000). The finding was similar in a cross-sectional analysis of children's pedaling. A higher percentage of older children, compared to younger ones, showed this organized cadence-associated response in muscle onsets (Chao, Rabago, Korff, & Jensen, 2002). As reported by Chao and Jensen (2004, this volume), all participants showed improvement in performance. Specific to the neuromuscular analysis, however, the bicep femoris muscle was the only one to reveal a training effect, with muscle onsets becoming more highly correlated with cadence after training. These findings support the hypothesis of experience as a significant modifier not only of performance (Chao & Jensen, 2004) but also of neuromuscular patterns. Further study is warranted to help us understand the differences in training intensity necessary to bring about more prominent neuromuscular changes compared to behavioral changes.

*Supported by National Science Foundation under Grant No. 9986221*

### **Objectified Body Consciousness: Effectiveness of a Body Consciousness-Raising Curriculum**

John, D., and V. Ebbeck. Oregon State University

McKinley (1995) used a social construction framework to theorize the negative impact of internalization of sociocultural body significance as objectified body consciousness (OBC). The Objectified Body Consciousness Scale (OBCS; McKinley & Hyde, 1996) was constructed to measure the three OBC components: body surveillance, body shame, and appearance control beliefs. In a  $2 \times 2 \times 5$  (Time  $\times$  Gender  $\times$  Class) quasi-experimental study, undergraduate female and male students ( $N = 87$ ) were participants in a curriculum designed to raise awareness of the influence of sociocultural messages on beliefs and behaviors associated with OBC as measured by the OBC scales. Data collected from undergraduate students ( $N = 114$ ) enrolled in courses with similar and dissimilar content served as comparison. The BCRC outcomes were quantitatively evaluated using RM-MANOVA. The analyses revealed a significant 3-way interaction  $F(12, 189) = 1.843, p = .039$ . Follow-up analyses disclosed that the interaction was primarily influenced by within-class gender differences across time, with no significant between-class differences. A qualitative evaluation of the BCRC from the students' perspective resulted in the identification of themes that indicated positive learning outcomes. The overarching trend indicates movement away from self-objectification and toward more subjective body awareness as well as positive bodily experiences.

### **Objectified Body Consciousness: Generality and Gender-Differentiated Associations With Physical Self-Conceptions and Physical Activity Behavior**

John, D., and V. Ebbeck. Oregon State University

The notion of objectified body consciousness (OBC), a feminist body-image perspective, and the associations with certain self-conceptions and physical activity behaviors were measured in undergraduate students ( $N = 394$ ). Consistent with previous research findings (McKinley, 1998), women reported significantly higher levels of OBC body surveillance and OBC body shame than men, with no significant difference in the levels of OBC appearance control beliefs between genders. Canonical correlation was used to explore the multivariate relationship between the set of OBC variables (body surveillance, body shame, and appearance control beliefs) and the set of self-concept variables (body self-efficacy, physical self-perceptions including strength, body attractiveness, conditioning, and sport competence, physical self-worth, and global self-esteem). The analysis revealed significant and different relationships between the set of OBC variables and the set of self-concept variables for both genders. The strength of association between the two sets of variables accounted for as much as 48% of the shared variance between the canonical variates for women and 29% of the shared variance between the canonical variates for men. A second canonical correlation, used to explore the relationship between the set of three OBC variables and physical activity behavior (weekly vigorous physical activity and MET levels), was nonsignificant for both genders.

### **Exploring the Relationship Between Motivation and the Communication of Training Plans in the Coach-Athlete Relationship**

Kabush, D. Canmore, Alberta

Coaching variables such as effective communication (Bloom, 1997; Culver & Trudel, 2000), training and instruction, information, and feedback (Allen & Howe, 1998; Black & Weiss, 1992; Horn, 1985) have been found to directly relate to athlete satisfaction and motivation. However, no studies have yet examined the most effective means of communi-

cating training plans to athletes in order to facilitate athlete self-determination. For instance, in accordance with Cognitive Evaluation Theory (Deci & Ryan), it is predicted that the manner in which a coach provides information to his or her athletes regarding training is a specific interpersonal behavior, which will be perceived as informational and autonomy-supportive by the athletes, in turn increasing their level of intrinsic motivation. In contrast, coaching environments in which little or no information is communicated to athletes about training plans are predicted to be perceived as controlling or pressuring, in turn decreasing athletes' intrinsic motivation. Thus the central purpose of this study was to explore athletes' experiences and preferences for how they communicate with their coach about training. Interviews were conducted with 14 athletes in 5 individual sports. The athletes had several years of experience in their sport and a wide range of experiences with coaches. The interview objectives were to explore athletes' (a) motivations for pursuing their sport, (b) goals, (c) history of coach experiences, (d) relationship with their present coach and its evolution, (e) how they communicate about training with their coach, and (f) how they prefer to receive training from a coach. The implications of communicating instructive training plans in advance on athlete motivation according to the athletes' preferences are discussed. This study provides a clearer understanding of which coaching variables can either hinder or facilitate athlete self-determination over time at different stages of an athlete's career.

### **Leadership Behaviors, Trust in Leader, and Athletes' Satisfaction in Sports Teams**

Kao, S-F.<sup>1</sup>, and C. Yu Fang<sup>2</sup>. <sup>1</sup>Chung Yuan Christian University; <sup>2</sup>National Taipei Teachers College

Although sport psychologists regularly emphasize trust between coaches and athletes (Giacobbi, Roper, Whitney, & Butryn, 2002; Murray & Mann, 1998), few empirical studies have tested the function of trust in sports teams. This study empirically examined the relationships among leadership behaviors, trust in leader, and athletes' satisfaction. We hypothesized that trust in leader mediated the relationships between leadership behaviors and athletes' satisfaction with their teams. Data were collected from 286 college athletes from 15 teams in Taiwan. The data strongly supported the mediated model and did not support the moderated model. The data showed that a leader's social support affects athletes' perceived trust in the leader than affects the athletes' pride in being a member of this team, playing on this team, and attending to this team. This study will conclude by discussing the limitations, implications, and further research.

### **Visual Search and Ambient Vision System Behaviors in Baseball Batting**

Kato, T., and T. Fukuda. Fujisawa, Japan

In this study we analyzed visual search activities of baseball batters during the preparatory phase of batting. Based on the experimental results, we discuss the function of ambient vision system behaviors under the dynamic environment. The results indicated there were differences in visual search strategies between experts and novices both in a field experiment and a simulation experiment. The distribution of experts' viewing points was smaller than that of novices on the whole. In particular, novices moved their line of sight up and down, being influenced by the movements of the pitcher. The moment the pitcher threw the ball, experts set their line of sight on the pitcher's elbow, not on the release point, while novices fixed on the shoulder-trunk region. As these results indicate, novices in batting tried to search detailed information about the pitcher and processed visual information depending on focal vision system, whereas experts in batting moved their eyes predictably adjusting to the pitcher's motion, used a systematic visual search strategy, visually evaluated the release point of the pitch efficiently, and utilized properties of ambient vision system.

### **Analyzing the Athlete–Coach Relationship in Successful Coaches in Japan**

Katsuro, K., S. Shigeru, and N. Takahiro. Tohoku University

The purpose of this study was to give an in-depth description of the athlete–coach relationship in successful coaches in Japan, taking into account their coaching philosophy in relation to coaching expertise development. Eleven coaches (one basketball and canoe, three soccer, two figure skate, and gymnastics) and three athletes of each coach served as participants for this study. In-depth open-ended interviews were used to gather data from the 11 coaches. The inductive analysis process resulted in regrouping these interview transcripts into two categories which show a significant agreement between coaches' perceptions of the concepts on how they evaluated their coaching activities in relation to commitment of the athletes, and how the athlete–coach relationship evolve coaching expertise development: (a) involvement, and (b) fulfillment. Results showed that successful coaches construct the relationship with athletes in a manner that maximizes athletes' commitment to deliberate practice.

### **Developmental Correlates of Fear of Failure in Young Female Athletes: A Cross-Sectional Study**

Kaye, M., D. Conroy, and J.D. Coatsworth. The Pennsylvania State University

Fear of failure (FF) is an avoidance-based expression of the need for competence. Accumulating evidence suggests that FF has childhood origins, yet very little research on FF in sport has involved children and youth. The present study documented different psychosocial characteristics associated with FF in childhood and adolescence (e.g., motivation and anxiety, social competence, self-concept) and examined the stability of this nomological network across critical developmental periods. At the beginning of a recreational softball season, girls ( $N = 93$ ,  $M$  age = 13.2 yrs,  $SD = 2.7$ ) completed the Performance Failure Appraisal Inventory, Sport Anxiety Scale, Situational Motivation Scale, Belonging Scale, Adolescent Competence Questionnaire, Rosenberg Self-Esteem Scale, Washington Self-Description Questionnaire, and four scales from the Physical Self-Description Questionnaire. As expected, general FF scores were associated with elevated levels of trait worry, somatic anxiety, concentration disruption, and high levels of amotivation; FF was not associated with intrinsic motivation, or identified or external regulations. With respect to social competence, youths who feared failing reported lower levels of academic and peer competence as well as greater levels of problem behaviors; FF was unrelated to activity competence or to perceptions of belonging to the team at the beginning of the season. In the self-concept domain, FF was negatively related to scores from both self-esteem measures as well as perceptions of global physical competence, coordination, and sport competence. Hierarchical multiple regression analyses revealed that FF was unrelated to problem behaviors for girls age 12 and younger, but positively related to problem behaviors for youths age 13 and older. None of the other effects were moderated by linear or quadratic age effects; thus the nomological network for interpreting FF scores was stable for girls 9 to 18 years of age.

### **Preseason Training for Breast Cancer Dragon Boat Participants: Psychosocial Correlates and Quality of Life**

Keats, M., S.N. Culos-Reed, T. Doyle-Baker, and C. Swirsky. University of Calgary

Physical activity has received growing attention and support as an intervention that may address the broad range of quality-of-life issues following a cancer diagnosis. One sport that is gaining recognition as an activity that fosters both physical and psychological health is dragon boat racing. The present study employed a prospective examination of the psychosocial correlates and outcomes of a dry-land training program. Participants were a

convenience sample of 20 (Time 1) breast cancer dragon boat paddlers who volunteered for a 10-week preseason training regimen. They completed a baseline and postassessment questionnaire that assessed demographic variables, past exercise, quality of life, and Theory of Planned Behavior (TPB) variables. Given the dual operationalization of perceived behavioral control in the TPB, a measure of self-confidence/ self-efficacy was also examined within the theoretical framework. The results revealed uniformly high QOL over the 10-week program ( $M = 73.3$  at Time 1;  $M = 79.2$  at Time 2). Multiple regression analyses demonstrated support for the TPB, as at both Time 1 and Time 2, perceived control (Time 1  $R^2 = 0.20$ ,  $p = 0.05$ ; Time 2  $R^2 = 0.40$ ,  $p = 0.03$ ) and self-efficacy (Time 1  $R^2 = 0.33$ ,  $p = 0.01$ ; Time 2  $R^2 = 0.50$ ,  $p = 0.01$ ) emerged as the only significant predictors of intention. Self-efficacy was found to be the most important determinant of actual exercise behavior within this group ( $R^2 = 0.59$ ,  $p = 0.01$ ). These results support the dragonboat training environment for promoting enhanced QOL, and also offer continued support for using TPB as a framework for conducting physical activity research with cancer patients and survivors.

### **The Effects of Response Uncertainty on Perceived Visual Illusions**

Keetch, K.<sup>1</sup>, C. Glazebrook<sup>1</sup>, D. Elliott<sup>1</sup>, J. Lyons<sup>1</sup>, M. Lam<sup>2</sup>, and D. Weeks<sup>2</sup>. <sup>1</sup>McMaster University; <sup>2</sup>Simon Fraser University

A recent study conducted in our lab found that individuals were differentially biased by Müller-Lyer configurations depending on the type of task they were required to perform. Specifically, they were biased by the amplitude of the figure when performing a perceptual task. In contrast, participants were biased by the perceived endpoint location when performing a manual aiming movement to the right vertex of these figures. For the present study we were interested in how individuals would code visual space when uncertain as to whether they would have to make a perceptual decision or manual aiming movement. Thus, participants performed blocks of both a perceptual and motor task separately, as well as in a combined fashion. In the combined condition the necessary response could be either perceptual or motor, and as a result was unknown to the participant. In the motor task, participants performed rapid aiming movements from the left vertex to the right vertex of the presented figure using a stylus with an infrared emitting diode (IRED) attached to the end. In the perceptual task they had to judge, by depressing an appropriate mouse button, whether a comparator line was shorter or longer than the shaft of an initially presented Müller-Lyer figure. In both protocols, visual information was occluded either at movement initiation/ decision-making or 3 sec prior to that time. Results of the motor task revealed that while participants undershot to a greater degree in the combined protocol, the effect of the illusion was consistent. Specifically, they were biased by the endpoint of the figures. The perceptual task revealed no effects for protocol, and participants responded in the expected direction for the standard Müller-Lyer configurations. When presented with the tails-left figure, they responded "longer" less often compared to the control figure and tails-right figure, which were not different from each other. These results suggest that individuals may prepare for both types of responses in a parallel fashion since illusionary biases do not change when there is response uncertainty.

### **Contextual Interference Effects on Acquisition and Retention of Pistol Shooting Skills**

Keller, G., and Y. Li. University of Memphis

The contextual interference (CI) effect on motor skill learning has been well documented in the literature; however, few studies have examined this effect using relatively complicated motor tasks. The purpose of the present experiment was to test the utility of introducing greater CI during the training of a pistol shooting skill requiring both speed and

accuracy. Twelve adult beginners practiced basic pistol shooting skill that involved three stages ranging in difficulty with respect to number and distance of targets. Participants were randomly assigned to either blocked or serial practice of these stages, after a 20-min brief training session. They all practiced a total of 10 trials for each stage. Each trial included multiple targets with two shots to each target. A 10-min delayed retention (3 trials for each stage in blocked format) was conducted following the completion of acquisition. The standard scoring system of the U.S. Practical Shooting Association was used to evaluate acquisition and retention performance. A 2 (practice condition: blocked vs. serial)  $\times$  6 (block: the last 3 blocks of acquisition and 3 blocks of retention) ANOVA with repeated measures was used for data analysis. Results were generally consistent with previous findings addressing CI. Individuals who trained under the blocked condition revealed superior performance compared to the serial practice participants at the end of acquisition, but retention performance was better for those individuals who experienced serial practice. Interestingly, this effect was more robust for the more complex stage.

### **Test, Revision, and Cross-Validation of the Physical Activity Self-Definition Model**

Kendzierski, D. Villanova University

Kendzierski, Furr, and Schiavoni's (1998) model of physical activity self-definition proposes that it is a function of both perceived commitment to the activity (i.e., perceived importance of the activity to oneself) and perceived ability in regard to the activity. Perceived commitment is seen as depending on perceptions that one wants to do the activity and that one is trying to do the activity. Other variables are hypothesized to influence self-definition indirectly through their effect on these four key variables. For example, enjoyment of an activity is thought to influence self-definition through its effect on perceptions that one wants to do the activity. Structural equation modeling was used to test the proposed relationships among self-definition, perceived commitment, perceived ability, perceived wanting to do the activity, perceived trying to do the activity, and enjoyment of the activity using data from a sample of 649 male and female runners/joggers, ages 18–70. Results were mixed: some fit indices ( $O^2$  and RMSEA) suggested that the original model did not fit the data well,  $O^2(115) = 1245.33$ ,  $p < .001$ ; RMSEA = .123. But other fit indices (CFI and NFI) suggested a very good fit: CFI = .971; NFI = .968. Model modification revealed that a better fit resulted with the addition of two paths: one from perceptions that one wants to do the activity to perceptions that one is trying to do the activity, and another from perceptions that one is trying to do the activity to perceived ability,  $O^2(113) = 587.21$ ,  $p < .001$ ; RMSEA = .080; CFI = .988; NFI = .985;  $O^2_{diff}(2) = 658.12$ ,  $p < .001$ . This revised model was then cross-validated with data from a sample of 436 male and female cyclists, ages 18–78. The model fit the cyclists' data fairly well,  $O^2 = 315.40$ ,  $p < .001$ ; RMSEA = .064; CFI = .992; NFI = .988. Consequently, the revised model was adopted.

### **The Role of Perceived Ability in Golfer Self-Definition**

Kendzierski, D.<sup>1</sup>, and C. Letourneau<sup>2</sup>. <sup>1</sup>Villanova University; <sup>2</sup>New York City

In Kendzierski, Furr, and Schiavoni's (1998) model of physical activity self-definition, perceived commitment and perceived ability are considered to be the immediate antecedents of self-definition. Kendzierski and Morganstein (2002) found that self-prototype match also plays a role in self-definition as a runner/jogger. Self-prototype match refers to the extent to which people consider themselves similar to the prototype (i.e., their concept of the typical person who engages in the activity). Hierarchical multiple regression analyses revealed that the addition of self-prototype match as a predictor of self-definition both increased the predictability of self-definition and resulted in perceived ability no longer mak-



ing a unique contribution to the prediction of runner/jogger self-definition. It was suggested that this may have occurred because running/jogging was not perceived as an activity that requires a lot of skill, unlike activities such as soccer and golf. Consistent with this idea, Hicks (2003) found that perceived ability uniquely contributed to the prediction of self-definition as a soccer player even when perceived commitment and self-prototype match were included as predictors. However, soccer differs from running/jogging not only in terms of perceived skill but also in that it is a team sport rather than an individual sport. The present study examined the role of perceived ability in self-definition in regard to golf, which is an individual sport like running/jogging but one that is perceived to require more skill than running/jogging. Results paralleled those of the soccer study: Hierarchical regression analyses revealed that, even with all three predictor variables in the equation, perceived ability continued to make a unique contribution to the prediction of golfer self-definition. This suggests both that perceived ability should be retained as a variable in the physical activity self-definition model and that the perceived skill level of an activity probably moderates the role of perceived ability in self-definition.

### **Motor Reactions to Visual Stimuli Which We Are Not Aware Of**

Kibele, A. Kassel, Germany

In cognitive psychology and psychophysics, phenomena linked to perception without awareness, subliminal perception, or unconscious cognition have been recognized for many years. In the past two decades these phenomena have been explored by methods that are recognized to establish unawareness. The case in which stimulus information has direct access to the motor system without its conscious perception has been termed "direct parameter specification" (Klotz & Neumann, 1999; Neumann & Klotz, 1994). The corresponding theory is derived from the work of Milner and Goodale (1995) on the visual system, which assumes a dorsal pathway for the processing of visual stimuli directly into the motor areas. In contrast, the processing in the ventral stream is required for conscious shape analysis and stimulus identification. While this explanation is appealing because it links the well-known phenomena from game sports and martial arts sports to a theory that has integrated a wealth of neuroanatomical, neurophysiological, and neuropsychological data, direct evidence to support it is still scarce. Based on the work of Neumann and co-workers with very simple choice-reaction key-press tasks, we have modified the underlying backward masking paradigm in order to examine more complex gross motor reactions involving large muscle groups as well as several reaction alternatives. In this report, the general experimental method for studying the direct parameter specification will be introduced. The backward masking effect will be demonstrated for different motor tasks and its limitations will be outlined. Furthermore, evidence will be provided for the processing of visual stimuli without awareness by the comparison of direct and indirect tests under similar conditions (i.e., Merikle & Reingold, 1991).

### **Movement Priming—Motor Reactions to Nonconsciously Represented Movement Features**

Kibele, A. Kassel, Germany

Can motor reactions be primed by the perception of movement sequences? This paper aims to outline a conceptual model to explain the stimulus-reaction behavior within rapidly changing and complex stimulus environments such as in game sports or martial arts as the result of a priming process. The term "priming" was introduced to cognitive psychology (Tulving & Schacter, 1990) to explain the influence of past experiences on the processing of words and objects in new tasks without remembering doing so. Preceding experiences with those stimuli are thought to be stored in a perceptual representation system that has

been shown to operate independently from other traditional memory systems (Badgayan, 2000; Tulving & Schacter, 1990). We assume that motor reactions are primed by nonconscious movement features embedded in the complex movement sequences of opponents or sports partners. The perceptual representation of those features and their triggering function to elicit adequate motor reactions are thought to be the result of an implicit learning process. Athletes from various game sports and martial arts confidently report on their successful motor reactions but are unaware of any particular visual trigger stimuli. This stimulus-reaction behavior (the tennis return to extremely fast serves, rapid table tennis action sequences, counterattack reactions in fencing, etc.) is found primarily in experienced athletes rather than beginners. Consequently, there is reason to believe that this behavior results from a learning process. Although athletes and trainers are well aware of the phenomenon, no theoretical background has yet been established to explain why participants successfully react to something they cannot report on. In our approach, a movement priming effect relies on the internal representation of nonconscious movement features and on the nonconscious elicitation of motor reactions by perceptual processes in action situations under time pressure. The latter is thought to be the result of a common coding of perception and action processes (Hommel et al., 2001). Experimental evidence from different fields of cognitive science will be provided to support the movement priming approach.

### **Motor Recovery of Upper Arm in Chronic Stroke: Kinetic Analysis of Isometric Wrist Extension**

Kim, S-B., and J.H. Cauraugh. University of Florida

Motor recovery from chronic hemiparesis is challenging throughout rehabilitation. Active neuromuscular stimulation has been used for an effective behavioral intervention for improvements in upper arm motor function after stroke. The current study examined the effect of active neuromuscular stimulation and training protocol (unilateral vs. bilateral). Twenty-five stroke patients volunteered to participate in this upper-extremity arm motor recovery protocol. They were randomly assigned to one of three groups: (a) bilateral training protocol with active EMG-triggered stimulation; (b) unilateral protocol training with active EMG triggered stimulation; and (c) control. All participants completed 6 hours of 12 training sessions during a 2-week period according to group assignments. Sustained isometric wrist extension movements with maximal efforts for 8 seconds were evaluated on the basis of kinetic measures of force. Mixed design analyses indicated motor function improvements for both bilateral and unilateral protocol groups compared to the control group. In addition, these findings indicate a shorter time to reach maximal force and a longer sustained force of wrist extension movement.

### **Age-Related Changes in the Moving Room: What is Developing?**

Kim, S., and J.E. Clark. University of Maryland

With increasing age, the postural response to a moving room is said to become better tuned to the visual stimulus. This finding is confounded by age-related sway reductions in quiet stance in the absence of a manipulated visual environment, suggesting that the tuning of the postural response to a dynamic stimulus may in part be accounted for by developmental changes in quiet stance alone. The purpose of the present study was to clarify whether age-related changes in response to the moving room reflect a response to the stimulus or to changes in the sway characteristics of quiet stance. Ten 4-year-olds, ten 6-year-olds, and ten adults were presented with a computer-generated visual stimulus that oscillated mediolaterally at 0.3 Hz with amplitudes of 0, 2, 5, and 8 mm. Participants stood in a heel-to-toe stance while kinematic measurements of the postural response to the visual stimulus were taken from the head, from which the measures of gain (ratio of sway to stimulus), stimulus fre-

quency sway amplitude (SFSA; numerator of the gain ratio), and residPSD (the area under the power spectral density function without the stimulus frequency component) were recovered. Repeated-measures MANOVA revealed significant age effects for residPSD,  $p < 0.05$ , indicating a decrease in sway across age groups. Significant Amplitude  $\times$  Age interactions were found in both gain and SFSA,  $p < 0.05$ . Post hoc analysis revealed that all age groups demonstrated responsiveness to the stimuli above their baseline sway, with 4-year-olds responding less than the older two groups. These results indicate that the age-related postural changes in the moving room paradigm are due to the children's responsiveness to the visual stimulus rather than the age-related changes in quiet stance sway.

*Supported by NIH (R01-HD042527-01)*

### **Discovery Learning vs. Guided Learning of Hearing Aid Insertion**

Klumpp, M., and R. Magill. Louisiana State University

The aim of this study was to compare the effectiveness of discovery learning vs. guided learning instruction techniques of in-the-ear (ITE) hearing aid insertion in healthy young adults. Participants were 10 female audiology students with no previous experience with hearing aid insertion. Mean age was 22.5 years and all but one were right-handed. Participants were randomly assigned to each group (discovery or guided learning). Custom ITE hearing aid shells, donated by Starkey Hearing Aid Company, were fitted to each participant's preferred hand side. An attempts score, instructor time, observation of movement characteristics, and subjective responses served as the performance and acquisition measures during practice, retention, and a bilateral transfer test. Results indicated that instructor time did not differ between groups during practice, and that while both groups performed no different during practice and retention, the discovery learning group successfully inserted the hearing aid more than the guided learning group during the bilateral transfer test. While data collection on healthy elderly persons is still in process, clinical implications of this study may already show that a discovery learning approach to hearing aid insertion may lead to minimal instruction time and better learning of proper hearing aid insertion.

### **Age-Related Differences in Muscular Force Application: The Effect of Segmental Growth and Its Dependence on the Force Magnitude Requirement of the Task**

Korff, T., and J.L. Jensen. University of Texas at Austin

Purposeful movement is a construction of the confluence of muscular and nonmuscular forces. The latter depend on both the task's force magnitude requirements and the performer's anthropometrics. For a given task then, muscular forces may require adjustment if the anthropometrics of performers differ. Since anthropometrics change in a nonlinear fashion during childhood (Jensen, 1989), age-related differences in muscular force application thought to be associated with neuromuscular changes might be confounded by differences in anthropometrics. The significance of this effect depends on the force magnitude requirements of the task. The goal of this study was to isolate the effect of nonlinear differences in anthropometrics on muscular force application during pedaling under different force magnitude requirements. A planar, torque-driven model of two-legged pedaling was developed. Using a forward simulation and an optimization algorithm, the model produced kinematics and forces similar to those produced by an experienced adult cyclist riding an ergometer at 75 rpm. The original model had adult anthropometrics which were then scaled to those of a 5-year-old child (Jensen, 1989). The forces to be produced were scaled by a linear factor while the kinematics were held constant. This way the effect of nonlinear differences of anthropometrics between children and adults on muscular forces was isolated, and confounding influences such as neuromaturation were eliminated. Pedaling at

moderate and low force magnitude requirements was simulated for both child and adult models. Mean squared differences between the adult and child models for the normalized muscular component of the tangential crank force increased as force magnitude requirements decreased. It was concluded that differences in anthropometrics have a significant influence on the force construction of the task only if force magnitude requirements are low.

*Supported by National Science Foundation under Grant No. 9986221*

### **Effects of State Anxiety on Measures of Reaction Time and Movement Time in Healthy Young Adults**

Kovacs, C., H. Webb, A. Long, and E. Acevedo. University of Mississippi

Woollacott and Shumway-Cook (2002) recently suggested that examining attentional demands during functional tasks is an emergent area of study. Increased anxiety could represent an attentional demand, resulting in impaired motor functioning in tasks that require fast reaction and movement times, such as driving an automobile or responding to changing environmental cues during functional motor tasks. This study was part of a larger, ongoing examination of the effects of state anxiety on upper extremity functional measures of motor performance in both younger and older adults. Changes in reaction and movement times as a result of increasing state anxiety/stress levels in young adults was the focus of this study. Using a pretest/posttest design, 22 young adult participants (mean age 20.05 yrs) were examined on reaction and movement time measures following an 8-min stress protocol. State anxiety was modified through the use of the Stroop Color word task and mental subtraction tasks between pre- and postmeasures. Changes in state anxiety were measured throughout the protocol using heart rate and blood pressure responses and the State Anxiety Inventory (Spielberger, 1975). Upper extremity reaction and movement times were examined using a Lafayette Instruments reaction timer system. Paired-sample analyses revealed significant differences,  $p < .037$ , from pre- to posttest for measures of reaction time. No significant differences were seen for measures of movement time,  $p < .095$ . These results suggest that increased levels of state anxiety may interfere with the speed of processing following the presentation of a stimulus, and may alter resultant motor functioning in healthy young adults.

### **Coping With Social Physique Anxiety: Strategies Utilized by Young Women**

Kowalski, K.<sup>1</sup>, D. Stevens<sup>2</sup>, C. Niefer<sup>1</sup>, and P. Crocker<sup>3</sup>. <sup>1</sup>University of Saskatchewan; <sup>2</sup>Brock University; <sup>3</sup>University of British Columbia

Body-related issues are associated with a number of health-related variables. However, specific constructs in the body domain such as social physique anxiety (SPA) have generally been studied in relation to specific behaviors (e.g., diet, physical activity) as opposed to from the perspective of coping and emotion theory. The purpose of this research was to examine coping strategies used by adolescent females to manage SPA. Participants were 398 young women (mean age = 15.4 yrs) who provided open-ended responses to a self-identified situation in which they experienced SPA. A total of 1,054 strategies were reported on the open-ended questionnaire and were then coded for content. The most commonly reported coping strategies were behavioral avoidance (reported by 41% of participants), appearance management (39.4%), social support (21.9%), cognitive avoidance (20.6%), and acceptance (19.6%). SPA in the self-identified situation was related to both trait SPA ( $r = .44$ ,  $p < .01$ ) and the number of strategies reported ( $r = .20$ ,  $p < .01$ ). Results also demonstrated that multiple coping strategies were often used to manage situations in which SPA was experienced, with the strongest link being between physical activity and diet (diet was reported in 54.3% of cases physical activity was reported).

*Supported by Social Sciences and Humanities Research Council of Canada (SSHRC) and the Saskatchewan Health Research Foundation (SHRF)*

### **Specificity of Practice and Gross Motor Tasks: Does it Exist?**

Krigolson, O., G. Van Gyn, and M. Heath\*. University of Victoria, BC; \*Indiana University

The specificity-of-practice hypothesis proposes that skill acquisition is dependent on the type of feedback available (Proteau, 1992). Furthermore, the specificity hypothesis predicts that reliance on a specific form of feedback increases with practice. Typically the practice specificity effect is demonstrated by having two groups of participants practice a skill with and without visual feedback. Following the acquisition phase of the experiment, both groups are transferred to a condition in which visual feedback is unavailable. Participants who practice without visual feedback maintain their level of movement accuracy in transfer, while those who practice with visual feedback demonstrate increased movement error. Using this type of paradigm, manual aiming studies have shown strong support for the specificity hypothesis (Proteau, 1992; Proteau et al., 1987). However, studies examining practice specificity in gross motor tasks have been equivocal (Bennett & Davids, 1995; Tremblay & Proteau, 1998). The present research examined the specificity-of-practice hypothesis in two gross motor tasks, walking and throwing. In both experiments the amount of practice and type of feedback available were varied between groups. Preliminary results show support for the first prediction of practice specificity hypothesis; participants who acquired a skill with vision demonstrated increased movement error when transferred to no-vision conditions. However, our results show conflicting evidence for the hypothesis that specificity increases as a function of practice. The results from several experiments aimed at explaining this result will be discussed. Issues relating to task difficulty and amount of practice will also be addressed.

### **Virtual Fixture Guidance in Virtual Training Environments**

Kuang, A.B., S. Payandeh, B. Zheng, F. Henigman, and C.L. MacKenzie. Simon Fraser University

A virtual fixture is a unit of a computer-generated virtual shape with haptics and/or graphics features that are designed to provide guidance along a preferred path, e.g., cone, cylinder, and sphere with force fields and graphic textures. Virtual fixtures could be used to construct various tunnel series in a complex virtual environment, providing graphic and force guidance. These fixtures are created to enhance human performance in teleoperated tasks and virtual environments. Virtual fixtures show improved performance in path-following experiments, through increased precision, increased speed, or both. We looked at the role of virtual fixtures in a training environment, where a combination of virtual fixtures guided a user through a complex scene toward the target destination along a preferred path. Path navigation task was performed with or without force field guidance by virtual fixtures, and then transferred to the condition with no guidance by the virtual fixtures. Results showed significant learning and transfer effects measured by performance time and path length. However, training using graphics and force guidance had comparable results to training with graphics only representing the path. Results are discussed in terms of motor learning theory and applications for the design of better VR training environments.

### **A Biomechanical Analysis of "High Guard" in Toddlers**

Kubo, M., and B. Ulrich. University of Michigan

At the onset of independent walking, toddlers position their arms in what has been called "high guard" rather than alternating and swinging them. The functional role of this peculiar arm posture has not been well elaborated. This study examined the contribution of the arms in new walkers from a biomechanical viewpoint. Five new walkers (4–6 steps max.) participated; 16 markers were attached to their joints and 3D kinematics of limb

movements were collected via the Peak Motus system during overground walking. A second data collection occurred after several weeks (1st visit at  $55.0 \pm 6.7$  weeks, duration between visits  $4.6 \pm 2.1$  weeks). The torques acting on the upper trunk due to the arms (Ta) and to the lower trunk (Tb) were estimated using inverse dynamics. Data were expressed in reference to upper-trunk-fixed local coordinates. We examined torques acting on the upper trunk in 3 directions: pitch (P), yaw (Y), and roll (R). A power spectral density analysis of the torques show a widespread frequency distribution for Ta and Tb, suggesting these are not functioning in a frequency-locking mode, and a reduced concentration of power, in contrast to adults. In addition, a relative phase analysis showed that Ta and Tb counteracted each other in all 3 directions. These features were common in all toddlers over both time periods; only the P component of TA varied in direction (forward/backward) among toddlers and over time, and related to arm position. We will present profiled data to argue that toddlers use their arms to create P torques to control their upper trunk in response to the destabilizing effect of “perturbations” generated by the lower trunk (legs). We propose that although raising the arms is logically problematic because it raises the COM, this effect is negligible. The utility lies in being able to affect the forward/backward pitch of the upper trunk, thus stabilizing the trunk over the hips as the legs generate the forces needed to propel the body forward.

### **Impact of Different Processing Times of the Efference Copy on Motor Learning**

Künzell, S. Institut für Sportwissenschaft, Giessen

It is widely accepted that the efference copy (EC) is used to anticipate the effects of movements. Jordan and Rumelhart (1992) proposed a model with a distal teacher for supervised motor learning. The EC and the environmental state are fed into a forward model that predicts the movements' effects and transduces, via back-propagation, the performance error to the error at the efference level. The desired effect and the environmental state are fed into an inverse model, which produces the efferent motor signals. Method: The effect of different processing times for the EC was examined in the present simulation. Processing time for proprioceptive feedback was set to 90 ms, and to 150 ms for visual feedback. Processing time for the EC copy was manipulated from an immediate processing (0 ms) to a processing time corresponding to visual feedback (150 ms) in steps of 30 ms (0, 30, 60, 90, 120, and 150 ms). A pursuit tracking task for implicit motor learning was used. Simulations were performed with a recurrent artificial neural network. Results: Simulations show that the pursuit tracking task was learned properly in all simulation conditions. Learning performance was similar to human learning. There are slight advantages for learning in simulations with shorter processing times for the EC than in those with longer processing times. Discussion: The results show that the Jordan and Rumelhart model is valid in a time-critical context. No conclusions can be drawn concerning the processing time for the EC in humans because of the similarity of learning performance in all simulation conditions. It is possible that mental imagery of the movement provides EC-signals long before the movement is actually executed.

### **Training of Explicit Estimation of the Movement's Effect Does Not Enhance Performance in Dart Throwing**

Künzell, S. Institut für Sportwissenschaft, Giessen

The mechanism of supervised learning with a distal teacher, developed by Jordan and Rumelhart (1992), postulates that motor learning is dependent on the comparison between the anticipated and the actual effect of the movement. We examined whether a training of the explicit formulation of the anticipated movement effect—the estimation of the

entry point—leads to an enhancement in motor performance. We trained skilled participants whose forward models were well developed. **Method:** We used a ballistic, open-loop controlled aiming task, dart throwing. Thirteen skilled dart throwers (6 treatment and 7 control) participated in a repeated measurement design. In pretest, posttest, and retention they threw 48 darts with visual feedback and 24 darts wearing PLATO-glasses that closed at the moment of dart release. This procedure inhibited visual feedback. Dependent variables were distance between the entry point and “bulls eye” for the throwing performance, and distance between the entry point and the estimation in the sightless condition for the estimation performance. In the treatment phase the participants threw 16 series of 40 blocks at 3 throws, each third throw with PLATO-glasses. They had to verbally estimate the entry point on the target and received visual feedback after estimation. Controls performed the same task without glasses. **Results:** Dart throwing performance did improve slightly, but not significantly,  $F(20.3, 1.8) = 2.375$ ,  $p = 0.12$ , with no interactions between time and group. In estimation performance the treatment group outperformed the controls. Interaction between time and group was significant,  $F(1.4, 15.1) = 4.37$ ,  $p = 0.044$ . **Discussion:** A training session with 1,920 throws is not enough to enhance skilled performance. Training of estimation of the landing point does advance estimation. However, a correlation between estimation performance and increased throwing performance could not be found.

### **Long-Term Hormone Replacement Therapy Improves Static Postural Control in Postmenopausal Women**

Kurek, J., J. Copeland, and L. Brown. University of Lethbridge

It is estimated that 30% of people over the age of 65 suffer falls every year. Interestingly, the prevalence of falls among women ages 65–75 is twice that of men of the same age, a factor possibly attributed to the natural loss of estrogen that occurs around the age of menopause. Hormone replacement therapy (HRT) can preserve muscle strength among postmenopausal women, and increased muscle strength does improve postural stability and reduce falls. However, despite this relationship, the effect of HRT on balance performance remains controversial. To help resolve this controversy, we compared static postural control between current HRT users and age-matched nonusers. Static postural control was assessed among 54 postmenopausal women: 27 current HRT users (mean age  $69.8 \pm 5.10$  yrs, mean HRT use  $13.15 \pm 8.14$  yrs) and 27 women who had never used HRT (mean age  $69.7 \pm 5.12$  yrs). Participants stood quietly on a force plate (Bertec) for 15-sec trials in both eyes-open and eyes-closed conditions. Root mean square (RMS) of postural sway in the anterior-posterior and the mediolateral dimensions was compared between groups. Results indicated that HRT users had significantly lower RMS values for the mediolateral dimension of sway than nonusers for both conditions,  $p < .05$ . Our findings imply that HRT use improves lateral stability. Based on the confirmed relationship between the magnitude of mediolateral postural sway and frequency of falls among older adults (Maki et al., 1994), our findings also imply that HRT can reduce the risk of falling.

### **Walking With a Chaotic Gait Pattern in a Reduced Gravity Environment**

Kurz, M.J., and N. Stergiou. University of Nebraska at Omaha

Earth's gravitational force plays an essential role in gait transitions, movement economy, and general terrestrial locomotive strategies for humans and animals. This suggests that movement strategies may be altered in a reduced gravity environment such as Mars. Recent studies have demonstrated the existence of chaos in gait patterns (Buzzi et al., 2003; Dingwell et al., 2000). They have indicated that structure of chaos is a window to the

control mechanisms of the neuromuscular system and the stability of locomotive patterns. However, no studies have explored the influence of gravity on the structure of chaotic gait patterns. Thus the present study explored the effect of altered gravity on the structure of chaotic gait. We utilized a passive dynamic double-pendulum walking model that traverses a slightly sloped surface ( $\gamma < 0.019$  radians) to examine the effect of gravity on chaotic gait. Previously we had shown that our model can exhibit a cascade of period doublings which lead to a chaotic gait pattern (Kurz & Stergiou, 2003). Changes in the model's locomotive pattern were noted with Poincaré maps composed from the step time interval of the model's right leg. Our simulations indicate that as gravity was increased, the order of the period- $n$  gait decreased. For example, a period-8 gait reduced to a period-4 gait, to period-2 gait and to a period-1 gait. Alternatively, as gravity was decreased, the order of the period- $n$  gait increased. Hence a period-4 gait was promoted to a period-8 gait, to period-16 gait, and to a chaotic gait. A reduction in gravity allowed for a chaotic gait pattern to evolve at ramp angles that were previously quantified as periodic. Based on our simulations, it was apparent that gravitational forces influence the structure of chaotic gait patterns. Thus we suggest that chaotic gait patterns will be altered when moving in reduced gravity environments such as Mars. This may be an important factor when considering stable locomotion for humans and the development of autonomous legged robots for the exploration of planets. Additionally, alteration of gravitational forces may be an important factor for rehabilitative measures that attempt to restore healthy chaotic gait in patients with stroke and spinal injuries. It may be necessary to initially reduce the effects of gravity during rehabilitation for the patient to transition to a healthy chaotic gait pattern.

### **Controlling Bifurcations and Chaos in a Passive Dynamic Walking Model**

Kurz, M.J., and N. Stergiou. University of Nebraska at Omaha

To better understand how inherent chaotic patterns arise in locomotion, we built a passive dynamic double pendulum walking model that can exhibit a cascade of period doublings which lead to a chaotic locomotive pattern (Kurz & Stergiou, 2003). Energy for the walking pattern is supplied by a slightly sloped walking surface ( $\gamma < 0.019$  radians). The purpose of this study was to explore whether joint actuations could be used to control the dynamics of our chaotic walking model. We extended our model by adding a hip torsional spring actuator ( $k$ ) between the swing leg and the torso and added an impulse at toe-off ( $P$ ) that was similar to ankle plantar-flexion at the end of the stance. We analyzed the locomotive patterns of our model from 5,000 footfalls, with the first 500 removed to be certain that the model converged to the given attractor. Changes in the model's locomotive pattern were noted with Poincaré maps composed from the step time interval of the right leg of the model. As the hip joint actuation increased ( $k > 0$ ,  $p = 0$ ), the order of the period- $n$  gaits at the respective  $\gamma$  were decreased. For example, a period-8 gait was reduced to a period-4 gait, to a period-2 gait, and to a period-1 gait. Additionally, hip joint actuation induced stability at  $\gamma$  where the model was not previously able to walk. The addition of a toe-off impulse ( $p > 0$ ,  $k = 0$ ) also influenced the locomotive pattern by increasing the order of the gait pattern. For example, a period-4 gait was promoted to a period-8 gait, to a period-16 gait, and to a chaotic gait as the toe-off impulse was systematically increased. Hence the toe-off impulse allowed for a chaotic gait pattern to evolve at ramp angles that were previously quantified as periodic. Our results support the notion that joint actuations can be used to induce stability in the gait pattern and promote transitions to new locomotive patterns available in the rich chaotic attractor. As such, it is possible that joint actuations are used by the nervous system to rapidly transition to any locomotive pattern available in the chaotic attractor that matches the given environmental circumstances. Such flexibility and optimization in performance cannot be demonstrated in systems that are not chaotic.



### **Liveliness and Wellness: Implications of Being Active for Physical and Psychological Well-Being Among Transitioning University Students**

Kwan, M., S. Bray, and N. Gyurcsik\*. University of Lethbridge; \*Kansas State

Transition to first-year university is a stressor for most students (Pennebaker, Colder, & Sharp, 1990), and exposure to stressful life events is associated with a higher incidence of health ailments. However, regular physical activity decreases the strain produced by stressors, and physical fitness has been found to moderate the stress/illness relationship (Brown, 1991). This study examined students' physical activity levels through transition in relation to their physical and psychological well-being. It was hypothesized that students who were sufficiently active through transition would have fewer colds and flu, and more positive psychological well-being than those who were insufficiently active. Participants were 87 first-year students ( $n = 62$  F), who completed the Godin Leisure Time Exercise Questionnaire, the General Health Questionnaire (GHQ), and a series of self-report questions concerning illness during their first semester of university study. Just over half (50.5%) of the students were insufficiently active (as per ACSM [1998] standards) during their first semester at university. Logistic regression analysis revealed that students who were insufficiently active were 3.9 times more likely to have had a cold ( $\beta = 1.36$ ,  $SE \beta = .63$ ,  $z = 4.72$ ,  $p < .05$ ) and 2.6 times more likely to have had the flu ( $\beta = 0.96$ ,  $SE \beta = .55$ ,  $z = 2.99$ ,  $p = .07$ ) than those who were sufficiently active. ANOVA showed a trend,  $F(1, 83) = 3.11$ ,  $p = .08$ , indicating that students who were insufficiently active also had higher levels of negative somatic symptoms as assessed by the GHQ. The results are consistent with an interpretation that being sufficiently active during transition to first-year university helps buffer the impact of transition-related stress on illness. Findings have implications for the well-being of students, the workloads of professors and healthcare providers, and healthcare expenditure. As such, interventions should target the performance of regular physical activity in first-year university students as a way to maintain or improve physical and psychological well-being.

### **The Effect of Task Type on Sources of Information During Motor Skill Acquisition and Performance**

Laguna, P. California State University Fullerton

The motor learning literature includes numerous studies on the influence of task-related sources of information (model demonstrations, physical practice, KP, verbal instructions) that facilitate motor skill acquisition. The results of these studies are ambiguous and it has been difficult to formulate a conclusion regarding the best source of information for motor skill acquisition. One factor that has been alluded to in many of these studies but not directly addressed is task type. Thus the purpose of this study was to examine task-related sources of information in relation to a simple vs. complex task. A total of 120 volunteer undergraduate students were randomly assigned (equal numbers of men and women) to one of two sets of 6 treatment strategies: (1) all model demonstrations; (2) model demonstrations with physical practice with KP; (3) model demonstrations with physical practice without KP; (4) physical practice without KP; (5) physical practice with KP; or (6) verbal instructions only. One set of the 6 strategies learned a complex version of a barrier task while the other set learned a simple version. Cognitive representation (CR) was assessed five times throughout acquisition and performance using a recognition test and a temporal timing test. Performance accuracy was also measured during the immediate and 72-hr retention practice trials using a spatial accuracy and a timing accuracy test. Results indicated that task type does influence which source of task-related information should be used to facilitate motor skill acquisition. When learning a simple task, either model demonstrations, physical practice with KP, or a combination of model demonstrations and physical practice with KP provide similar information for developing an accurate CR. In addition,

these three information strategy groups demonstrated similar performance accuracy. However, with a complex task the combination of model demonstrations and physical practice with KP significantly outperformed all other information strategies in both CR development and performance accuracy. The results provide insight on the ambiguity that exists in the observational learning and motor learning literature regarding the effectiveness of information sources for motor skill acquisition.

### **Effects of Foreperiod on Simple and Choice Reaction Time**

Lai, Q.<sup>1</sup>, J. Su<sup>2</sup>, and Z. Huang<sup>3</sup>. <sup>1</sup>Wayne State University; <sup>2</sup>University of Nevada Las Vegas; <sup>3</sup>Beijing Sport University

Foreperiod (FP) is the interval between a warning stimulus and a response stimulus. The previous studies demonstrated that constant FP or aging FP facilitated anticipation and consequentially reduced simple RT. The constant or aging FP effect was attributed to the increased probability of the presentation of a response stimulus. However, the previous studies did not involve choice RT paradigm. Unlike simple RT, choice RT does not have a parameterized motor program before a warning stimulus. A participant must assign a parameter (e.g., which key to depress) for the motor program after a response stimulus is presented. We hypothesized that choice RT was not sensitive to the variation of FP, i.e., constant vs. random. To test the hypothesis, the 10 participants in the experimental group were asked to depress one of the four keys on a PST serial response box after the presentation of associated response stimuli on a computer monitor. Another 10 participants were assigned to the control group in a simple RT condition. During practice, the response stimuli (or stimulus) were presented 2, 3, 4 sec in random order or 3 sec with the repeated FP after a warning stimulus. Participants were informed that the maximum latency between the warning stimulus and the response stimulus was 5 sec. ANOVA analysis revealed that repeated FP (constant) or 4-sec FP (aging) resulted in faster simple RT compared to random FP or 2-sec FP. But the analysis failed to detect the differences in choice RT condition. The present experiment indicated that temporal anticipation was effectively developed only when the motor program was parameterized before the foreperiod.

### **The Non-Normality Examination of Discrete Aiming Movements**

Lai, S-C., and K. Newell. The Pennsylvania State University

Distribution of the trajectories of discrete aiming movements was explored over a wide range of spatial (20–160 mm) and temporal (250–1250 ms) constraints in order to examine the traditional assumption that aiming movements have a normal distribution. Information entropy was calculated using two distinct analyses: (a) assuming the data have a normal distribution; and (b) no assumption on the nature of the data distribution. The two analyses showed different patterns in the estimate of entropy, suggesting that data distribution at each time point of the discrete aiming movements was not normal. In addition, the skewness analysis revealed that the actual distribution of the aiming tasks varies from positive to negative skewness as a function of movement time. These findings strongly contradict the conventional assumption of a normal distribution of the trajectories of aiming movements, but they are consistent with the earlier reports of non-normal distributions of both spatial and temporal outcome scores.

### **Attention and Affordance in the Facilitation of Object Identification**

Lamb, M., K. McFee, S. DeTar, D.J. Weeks, and R. Chua\*. Simon Fraser University; \*University of British Columbia

Tucker and Ellis (1998) showed that participants react more quickly to identify a common household object with their right hand if the graspable surface of that object is also

oriented to the right. A similar benefit is observed when the left hand is the effector of response and the object is oriented to the left. Tucker and Ellis suggested that this hand-of-response by object-orientation interaction reveals an "action system" with an inherent predisposition to take advantage of perceived object properties that automatically potentiate components of the actions they afford. However, Lyons, Weeks, and Chua (2000) showed that the hand-of-response by horizontal-orientation interaction could be eliminated by including two equally graspable surfaces in the stimulus array. Furthermore, the interaction reappeared when the stimulus set included objects that allow for unimanual grasp and manipulation (e.g., pot, teacup) as well as objects that in reality do not (e.g., giraffe, helicopter). An alternative explanation is that diversion of spatial attention toward one or the other side of action space interacts with directional codes developed on the basis of premovement attention shifts. In the present experiment, participants identified object orientation in the context of a cost-benefit paradigm (Posner, Nissen, & Ogden, 1978) in which the orientation of the object cued (80% valid) the onset of a lateralized target stimulus. The graspable surface (a handle) was randomly oriented to the right or left for valid-, invalid- and neutral-cued trials. The results revealed a Validity  $\times$  Target  $\times$  Handle Orientation interaction in which the effect of target-handle orientation compatibility was reversed for the valid and invalid cue conditions. There was no compatibility effect for the neutral cue condition. This context specificity suggests a process of cognitive coding and provides further evidence against an explanation based on the notion of ecological affordance.

*Supported by grants from the Human Early Learning Partnership and the Natural Sciences and Engineering Research Council of Canada*

### **Developing Aquatic Skill: Does Teaching Work?**

Langendorfer, S., and A. Hardy. Bowling Green State University

In the fable of Chanticleer, the rooster makes an all-too human error of confusing correlation with causation when he presumes his crowing makes the sun rise. Like Chanticleer, many aquatic clinicians (e.g., instructors and coaches) presume that their teaching and coaching practices "cause" their students and athletes to improve their swimming skill. An alternative hypothesis, that swimmers improve *in spite of* the specific teaching and coaching practices to which they are subjected, has rarely been considered. We looked at an alternative view of the swimming skill acquisition process by examining intraindividual variability associated with developmental changes in prone swimming behavior across trials and across occasions. We tested three groups of individuals longitudinally over the course of swimming lessons or swim team practice by videotaping participants repeatedly, either weekly, monthly, or bimonthly, depending on the sample. Sample 1 included 20 children, ages 6 mos. to 10 years sampled weekly; Sample 2 had 40 participants, ages 4 to 17 years, sampled monthly; Sample 3 included 23 young adults, tested every 2 months. Depending on the sample, participants swam 3–5 trials using an alternating front stroke such as front crawl or beginner stroke. After establishing inter- and intraobjectivity of  $p > .90$ , we played the 30-hz digital videotaped trials of each participant swimming in slow motion and categorized swimming behavior into component developmental levels for body position, arm propulsion, arm recovery, leg kick, and combined action components (Langendorfer, 2003; Langendorfer & Bruya, 1995). Graphic analysis of the across-trial variability revealed that body position and arm position developmental levels were the most variable among the least skilled swimmers, while the advanced swimmers' behavior was remarkably (>90%) consistent at each time point. Across longitudinal testing occasions, intraindividual variability obviously was greater for all components, and naturally greatest among the individuals whose initial swimming behavior was the least developmentally advanced. Observed changes for the most part were made to adjacent ordinal developmental levels, as proposed

by developmental sequence theory and previous research. Of particular interest was the observation that intraindividual variability was related across time scales, indicating that teaching may have limited impact on the swimming skill acquisition process. Future research needs to explicitly test changes in variability associated with specific aquatic teaching techniques using experimental groups matched to control groups.

### **Age-Related Differences in Self-Selected Parameters of Continuous Movements**

Lantero, D., S. Ringenbach, and M. Jung. Arizona State University

This study examined the temporal, spatial, and coordination preferences of typical adults and typical children when drawing continuous unimanual (Uni) and bimanual (Bi) circles. Participants ( $n = 12$  per group) were adults (AD), 8-year-olds (CH8), 6-year-olds (CH6), and 4-year-olds (CH4). They self-selected movement time, size, and coordination pattern (Bi only) of circles drawn. A trial lasted for 30 sec, but to examine the influence of sustained attention, we divided each trial into three 10-s blocks for analysis. Mean movement times significantly slowed as the trial continued only for the CH6 and CH4 groups, while AD and CH8 groups maintained consistent times across all three blocks. This indicated difficulty with sustaining attention at younger ages. Hand asymmetries were found in mean diameter for the CH6 and CH4 groups but not for the AD or CH8 groups. There was a significant amount of asymmetry between mean diameter of circles during the Bi condition as the left hand produced smaller circles, thus not demonstrating the anticipated magnet effect commonly found in continuous bimanual coordination tasks. There was a main effect for age for the circularity of circles drawn, with the older groups producing more circle-like shapes and the younger groups producing more oval-like shapes, perhaps as a result of the number of degrees of freedom utilized by the performers while drawing. As expected, stability in coordination increased with age, as illustrated by less time spent in the intermediate phase and a lower standard deviation of mean relative phase in the older groups. The results will be discussed regarding age-related differences in self-selected parameters of continuous movements.

### **Effects of Videotape Self-Modeling on Figure Skating Jump Performance and Psychological Variables**

Law, B., and D. Ste-Marie. University of Ottawa

The purpose of this within-participant study was to determine whether a self-modeling intervention would improve figure skaters' jump performance (outcome and form) as well as various psychological variables (self-efficacy, state anxiety, and motivation) when compared to physical practice alone. Twelve figure skaters participated in the 5-week intervention which consisted of a pretest, 6 intervention sessions scheduled twice per week, and a posttest held 1 week after the end of the intervention. Two jumps were selected for each skater and pseudo-randomly assigned to either the self-modeling or control condition. For the self-modeling jump, skaters watched a videotape of themselves performing the jump successfully before physically practicing the jumps, while they did not see a videotape of the control jump. To examine the effect of the intervention, a  $2 \times 2$  (Condition  $\times$  Time) repeated-measures ANOVA was performed for each dependent variable. A marginally significant Condition  $\times$  Time interaction,  $F(1, 11) = 5.6, p = .038$ , was obtained for the performance outcome. The scores for jumps in the self-modeling condition increased from the midpoint ( $M = 4.8, SD = 2.2$ ) to the end of the intervention ( $M = 5.1, SD = 1.9$ ), while scores for jumps in the control condition decreased from the midpoint ( $M = 5.0, SD = .9$ ) to the end of the intervention ( $M = 3.7, SD = .9$ ). There was no effect on any other dependent variable.

One-way ANOVAs of the posttest data showed that the intervention had no lasting effects on skaters' performance or psychological variables. Despite this, follow-up questionnaires from the skaters indicated that they enjoyed the intervention and felt that indeed their jump performance had improved. Skaters also indicated that they would like to incorporate this technique into their regular training and competition routines.

### **Utilization of Peripheral and Central Vision in an Amplitude Aiming Task**

Lawrence, G.<sup>1</sup>, M. Khan<sup>1</sup>, E. Buckolz<sup>2</sup>, and I. Franks<sup>3</sup>. <sup>1</sup>University of Wales; <sup>2</sup>University of Western Ontario; <sup>3</sup>University of British Columbia

Researchers have suggested that visual feedback not only plays a role in the correction of errors during movement execution but that visual feedback from a completed movement is processed offline to improve programming of subsequent trials. The purpose of the present study was to examine the utilization of peripheral and central vision during movement execution (i.e., online) and as a form of knowledge of results in the programming of upcoming trials (i.e., offline). Participants performed a single degree-of-freedom amplitude aiming task on a digitizing tablet (movement time = 450 msec). The movements were performed with visual feedback throughout the movement (Full Vision), visual feedback from 40° to 10° eccentricity (Peripheral Vision), visual feedback from 10° to 0° eccentricity (Central Vision), and without any visual feedback (No Vision). The potential contribution of online and offline processing of visual feedback was examined by analyzing spatial variability at various kinematic landmarks in the limb trajectory: peak acceleration, peak velocity, peak negative acceleration, and movement end. The results indicated that movements were less variable in the Full and Central Vision conditions than in the Peripheral and No Vision conditions. Analysis of the form of the variability profiles revealed that the benefit of visual feedback in the Full and Central Vision conditions was due to adjustments in limb trajectories during movement execution.

### **Exploring the Relationship Between Sensory Integration Motor Ability and Emotion on Preschool Children**

Lee, C-Y., J-H. Lin, F-H. Sung, H-H. Shih, C-L. Hung, and T-M. Hung. Taipei, Taiwan

The psychological benefits of physical activity have been widely documented. Among these benefits, emotional effect has been the focus of research. Although researchers have shown that physical activity has a positive effect on emotional variables such as anxiety and depression in different demographic groups, little is known about its effect in young children. Thus the purpose of this study was to explore the relationship between sensory integration motor ability and emotion on preschool children. Participants were 273 preschool children in Taipei. All were evaluated by the Basic Motor Ability Tests-Revised (BMAT-R). In addition, the Scale for Assessing Emotion Disturbance (SAED) was administered to teachers and parents. Descriptive statistics and Spearman rank correlation were employed to analyze the data. The results revealed: (1) Some subscales of the sensory integration motor ability tests were correlated with each other and with its total score. (2) Every subscale of the emotional tests was correlated with each other and with its total score. (3) Although the relationship between the total score of the sensory integration motor ability tests and that of the emotional tests was not significant, some subscales of the sensory integration motor ability tests were correlated with some of the emotional tests. Therefore, prospective examinations as well as experimental designs are recommended for future research, in order to further understand the relationship between sensory integration motor ability and emotional development.

### **Practice Schedules in Learning a Manipulative Task: Skilled vs. Novice**

Lee, E., and A.M. Gentile. Teachers College, Columbia University

We examined the effects of skill level and practice schedule (blocked vs. random) on learning to use chopsticks to pick up and transport different sized buttons. Participants had either extensive (skilled) or limited (novice) prior experience in using chopsticks. Total movement time (MT), partitioned into initial positioning/pick-up and transport phases, was measured during acquisition and retention tests. During acquisition the novices demonstrated slower MTs under random practice than blocked for the first set of trials. However, the groups did not differ by the end of training. On retention tests the novices performed better following random than blocked practice. For the skilled participants, practice schedules had no effect during acquisition and retention tests. To evaluate transfer effects, we analyzed kinematics of the transport movement in a similar task (i.e., transporting larger object) before and after training. Although no practice schedule effects were found, both groups demonstrated significant improvement on several kinematic measures from pre- and posttests. Thus, regardless of practice schedule, positive transfer occurred from practice on the acquisition task. Additionally, the velocity profiles of novices changed from variable and multi-peaked to consistent and smooth, which were similar to initial profiles of skilled participants. The superior learning of the complex manipulative task by novices under the random schedule is discussed with respect to prior studies using whole-body sport tasks.

### **Learning Effects on Attentional-Focus Feedback and Optimal Presentation**

Lee, H-W., and D.W. Yook. Yonsei University

Three studies were conducted to examine the effects of external-focus verbal feedback on learning sport skills such as bowling. Experiment 1 was designed to examine effectiveness of the internal and external-focus verbal feedback on learning basic bowling skills. Experiment 2 was to test the guidance hypothesis for the external-focus verbal feedback. Conditions of Experiment 2 consisted of 33%, 50%, and 100% feedback groups. Experiment 3 was designed to compare the effectiveness of different feedback presentations (i.e., self-control, yoked, 100% external-focus verbal feedback group). Participants were 90 right-handed middle school students who were randomly assigned to Experiment 1, 2, or 3 ( $n = 30$  per group). Each design of these studies was  $3$  (group)  $\times$   $3$  (game)  $\times$   $2$  (day),  $3$  (group)  $\times$   $2$  (game)  $\times$   $2$  (day), and  $3$  (group)  $\times$   $2$  (game) factorial design. Three-way ANOVA with repeated measures was conducted to analyze the bowling performance scores consisting of game and form score. The results of these studies showed that: (a) the external-focus verbal feedback was more effective than internal-focus verbal feedback; (b) the guidance hypothesis was not supported, that is, 100% external-focus verbal feedback was more effective than 33% and 50% feedback for retention test; and (c) the self-controlled effect was not found when the verbal statements of the external focus feedback were provided. Consequently, providing after every trial turned out to be the most appropriate method for presentation. The implication of these studies was that external focus verbal feedback right after every trial was a very important strategy for teaching sport skills. Recommendations for future study are discussed.

### **An Investigation of the Intention of Walking Behavior: An Application of the Theory of Planned Behavior**

Lee, P-H., and S. Liu. National Chung Cheng University

The purpose of this study was to predict the intention of walking behavior by using Ajzen's Theory of Planned Behavior, and explain the factors that determine walking behavior.

ior. A walking behavior questionnaire was developed and tested by the researchers. The reliabilities for each factor ranged from Cronbach's  $\alpha$  .80 to .96. Participants were randomly selected from Taichung county citizens who were over 18 years of age, and 106 valid questionnaires were retrieved. The data collected were analyzed via chi-square test for homogeneity, Pearson product-moment correlation, and hierarchical multiple regression analysis. The results were as follows: (1) 78.1% of Taichung citizens used walking as an exercise in the month prior to completing the questionnaire, but only 11.4% of them walked at least 3 times per week. (2) There were significant differences in the intention of walking behavior from an educational background ( $\chi^2 = 24.65$ ) and perceived health status ( $\chi^2 = 15.89$ ) between frequent walkers and nonfrequent walkers. (3) There were highly positive correlations among attitude, subjective norm, perceived behavior control, and their belief. (4) Intention of walking behavior was significantly predicted by subjective norm ( $t = .273, p < .01$ ) and perceived behavior control ( $t = .388, p < .01$ ). The total explained variance for the direct and the indirect (belief-based) measures were 55% and 51%, respectively. (5) The results of path analysis showed that the direct and indirect measures of variables fit the theory model.

### **The Effects of Short-Term Hand-Arm Vibration on Human Motor Performance**

Lehman, D., and M. Fischman. Auburn University

Dexterity, proprioception, coordination, and reaction time are all aspects of movement that are important when using hand tools. People using hand tools for occupation or recreation rely on precise hand movements for quality work production. Tools, whether electric or pneumatic, produce vibration which can be transferred to the hand and arm and may contribute to fatigue, loss of hand or tool control, and increased reaction time. Although ample research on the long-term effects of hand-arm vibration (HAV) exists, there is little research on the short-term effects of HAV on human motor performance. This study examined the motor performance of 18 healthy, college-age men and women. Participants practiced four motor tasks: Purdue Pegboard test; two-arm coordination test; simple reaction time; and a kinesthesiometer test. They then performed these tasks before and after being exposed to HAV. The vibration apparatus consisted of a pair of handle bars connected to a shaker table which created a vibration profile (150 Hz, 2-mm amplitude) similar to that of a hand tool. Participants held onto the handles for three intervals of 5 minutes. Immediately after each 5-min interval of HAV, they performed one of the four motor tasks. No significant difference was found between genders for any of the tasks, nor was there a significant difference between the pretest and posttests of any task. However, during post-experiment interviews, all participants said they felt they had to concentrate more on the posttests than they did during the pretest or practice trials, implying that there may be an increased attention demand immediately following exposure to vibration.

### **Psychological and Physiological Determinants of Overtraining and Burnout in Elite Swimmers**

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Burnout has been defined as a state of mental, emotional, and physical exhaustion (Freudenberger, 1980) brought on by persistent devotion to a goal, without recognizing the need to recuperate, in the quest for a goal that may be opposed to reality. Recently, as interdisciplinary research has taken a closer look at athlete burnout, some researchers (Gould, 1996; Hall et al., 1997) have suggested that "motivation gone awry" may play an important

role in the onset of burnout. When an athlete is overtrained, motivation remains, whereas the burned-out athlete may devalue sport and express cynicism. In an attempt to better understand the determinants of athlete burnout, this study looked at motivational disposition, perception of the motivational climate, the quality of motivation in elite athletes, variation in basal cortisol levels, and how these variables predicted levels of burnout in elite swimmers at season's end. It was hypothesized that maladaptive motivation shifts, together with variation in basal cortisol in elite athletes, can better predict overtraining and burnout at season's end. An elite American college swim team (32 M, 21 F) was recruited to participate in this study. Questionnaires assessing motivation were used together with a two-bout exercise test at three time points during the year, corresponding to the easy, very hard, and peaking time periods of the season. A protocol of  $6 \times 200$ -m intervals during morning and afternoon training practices was used at each time point. Venous blood was drawn before and after each set of intervals, as well as the following morning, and was assayed for cortisol by radio-immune assays. Using linear regression analysis, results indicated that basal cortisol variation as well as perception of a high performance climate on the team predicted burnout at season's end. When looking at the quality of motivation in swimmers at season's end, intrinsic motivation was negatively correlated to burnout whereas external regulation and amotivation were positively correlated to burnout levels. Enduring high basal cortisol variation is not beneficial to recovery and may lead to overtraining and ultimately to burnout. These findings are interesting, as they stress the importance of the external factor (motivational climate) on the quality of motivation of an athlete and a subsequent perception of burnout during the competitive season.

### **Expectancy and Value Beliefs in Sport: The Perspective of Young Taiwanese**

Liao, C-M., C-P. Lin, Y-J. Liu, and Y-L. Lee. National Taiwan College of Physical Education

According to Eccles' expectancy-value model, individuals' expectations of success and subjective task value are valid predictors of achievement behaviors. Eccles' work on adolescents has given primary validity to the structure of expectancy and value beliefs. It is arguable, however, whether structures of these beliefs, especially value beliefs, can be highly culture and/or development-dependant. In this study we extended Eccles' work on examining the structure of expectancy and value beliefs in the athletic domain with three major changes: First, our sample is from a Taiwanese/Chinese cultural background whose value beliefs may differ from those in North America. Second, our sample comprised individuals in various developmental stages, including students in Grades 4, 8, and 11 as well as college sophomores. Third, the concept of cost was included. Cost is one component of value, according to Eccles, but it has seldom been examined. Participants ( $N = 1,087$ ) completed a Chinese version of the Self- and Task-Perception Questionnaire with 10 cost-related items added. Factor analysis for adolescents and young adults showed a 4-factor solution including ability/expectancy, task value, required effort (cost), and fear of failure (cost). For young children, a 4-factor solution was also found, including ability/ expectancy/ task difficulty, task value, loss of valued alternatives (cost), and significant others' expectations (cost). These findings are consistent with Eccles' notion that expectancy and value beliefs are two separate concepts. For Taiwanese, however, the positive aspect of value seems to be a global rather than a 3-dimensional concept (attainment, intrinsic, and utility) found in North American samples. Cost, the negative aspect of value, appears to be a multidimensional concept. Adolescents and young adults are concerned about required effort and failure, while young children worry about loss of valued alternatives and expectations of others.



### **The Relationships of Goal Orientation, Perceived Motivational Climate, and Sources of Sport-Confidence on College Baseball Athletes, Taiwan**

Liao, W-N., Y-C. Kao, C-W. Lee, C-C. Chou, C-W. Lin, and C-H. Chen. Taipei, Taiwan

The purpose of this study was to examine the differences between college athletes of different divisions (I, II, and III) on goal orientation, perceived motivational climate, and sources of sport confidence on baseball, Taiwan. In addition this study looked at the relationships of goal orientation, perceived motivational climate, and sources of sport-confidence on baseball athletes. The participants were 451 college athletes who participated in quarterfinal and semifinal competitions in the 2002 regular season of college baseball. Their average age was  $20.75 \pm 2.06$  yrs, and they averaged 6.67 yrs ( $\pm 3.59$ ) of athletic training. This study used one-way ANOVA, Pearson correlation coefficient, and multiple regression to analyze data. The results were as follows: (1) There was a significant difference between divisions of college athletes on ego orientation on baseball athletes,  $F = 3.44, p < .05$ . Further, the college athletes of Div. I were significantly higher than those of Div. III on ego orientation. There was also a significant difference between different divisions of college athletes on perceived ego motivational climate in college baseball,  $F = 7.41, p < .05$ . Statistical results indicated that the college athletes of Div. I were significantly higher than those of Div. I and II on perceived ego motivational climate in college baseball. (2) There was a significant positive relationship between task orientation, ego orientation, perceived task motivational climate, and perceived ego motivational climate in college baseball athletes. Also, their task orientation was significantly positively related with mastery, demonstration of ability, physical/mental preparation, social support, coaches' leadership, vicarious experience, and situational favorableness. On the other hand, ego orientation of the college athletes was significantly positive correlated with demonstration of ability, physical/mental preparation, physical self-preparation, vicarious experience, and situational favorableness. (3) The results of the multiple regression model indicated that the factors of vicarious experience, social support, mastery, coaches' leadership, and perceived task motivational climate could predict task orientation in college baseball athletes. On the other hand, demonstration of ability, situational favorableness, and perceived task/ego motivational climate could predict ego orientation in college baseball athletes.

### **Effects of Verbal Instructions and Age in Observational Learning**

Liao, C-M., H-T. Wu, and C-C. Chiang. National Taiwan College of Physical Education

Empirical work has shown that verbal instructions influence the acquisition of motor skills in observational learning. Coaches and PE teachers often convey evaluative comments on the skill to be learned while giving verbal instructions, e.g., "This one is easy, you will get a grip on it very quickly" (a positive comment) or "This is a tough one, it will take some time" (a negative comment). However, little research has examined the possible effects of positive and negative comments prior to a demonstration on observational learning. This study extended previous work by Weiss (1987, 1992) by considering factors of instructor's comments, development, and learning stage on performance and self-efficacy. Children ( $N = 60$ ) comprising two age groups (9 and 12 years) were randomly assigned to positive, negative, and no-comment conditions to learn a six-part motor skill sequence by observing a model. Data in acquisition and retention phases were analyzed by either  $2 \times 3 \times 3$  or a  $2 \times 3 \times 2$  (Age group  $\times$  Comment type  $\times$  Trial blocks) repeated-measures ANOVAs, respectively. For performance scores, a three-way interaction in acquisition phase and an Age group  $\times$  Comment type interaction in retention phase were found. Younger children outperformed older ones in the positive-comment condition in the early stage of learning. In the retention phase, older children outperformed younger ones in the negative-comment condition. Younger children, but not older ones, who received positive comments performed

better than those in the no-comment condition. For self-efficacy scores, significant three-way interactions were found in both acquisition and retention phases. In the early stage of learning, older children had higher efficacy than younger ones in the no-comment condition, and younger children who received either positive or negative comments had higher efficacy than those in the no-comment condition. In the later stage of learning and retention phase, efficacy of younger children who received positive comments increased and was higher than that of older ones in the same condition. In conclusion, verbal instructions with evaluative comments seem to have a stronger facilitate effect for younger than older children on both performance and self-efficacy, and the effect varies across stages of learning.

### **Concussion History and Cognitive Performance Among Contact and Noncontact Sports**

Lilley, S., B. Raudenbush, and D. Dennis. Wheeling Jesuit University

The present study examined the effects of receiving a concussion on cognitive performance. A total of 140 Division II athletes from various sport teams (men's soccer, women's soccer, men's basketball, women's basketball, women's volleyball, men's lacrosse, and women's softball) completed a baseline cognitive performance test using the Impact Concussion Management Program. In general, male basketball players had significantly lower scores in word memory compared to the other sports teams. Athletes with a concussion history performed many cognitive functions less well than those not having previous concussions. The number of concussions, however, was not a factor in worsening cognitive functions; athletes who had had three or more concussions did not perform differently from those athletes having only one concussion. Such a result provides additional support for the importance of protecting athletes during game play, since only one concussion incident can promote a significant decrease in cognitive functioning.

### **The Performance-Learning Distinction for Implicit Learning After Stroke**

Lin, J., and C. Winstein. University of Southern California

The performance-learning distinction has been recognized for some time in both behavioral and neurobiological science. The purpose of this pilot project was to apply the performance-learning distinction in our analysis of implicit procedural learning (serial reaction time task, SRTT) in adults with and without unilateral brain damage. **Methods:** 14 right-handed adults: 8 stroke (age 61 yrs; stroke duration 19 mo; Fugl-Meyer motor 56) and 6 controls (57 yrs) practiced a visually-cued four-choice SRTT in which 10-element sequences were either repeating or random. Twelve blocks of 100 elements (10 elements  $\times$  10 repetitions/block) were practiced. Participants were unaware that the 1st and 11th blocks were random and others were repeating. Mean median response time change scores were calculated. Two performance: global (12th–1st block); repeating blocks (2nd–10th block); and two learning: transfer-disruption (10th–11th block); and transfer-recovery (12th–11th block) change scores were derived. An effect size (ES) was calculated to estimate the magnitude of group differences. **Results:** Performance change scores were higher for stroke (moderate ES .63, .59, while the learning change scores were lower (large ES .72, .74) than for controls. **Conclusion:** The performance-learning distinction may be useful for evaluating implicit learning capability after stroke.

### **Does Gender Moderate the Relationship Between Movement Ability and Preschoolers' Brain Development? An EEG Study**

Lin, J-H., H-H. Shih, S-C. Lin, Y-J. Chen, C-W. Chang, and T-M. Hung. Taipei, Taiwan

Past research has shown that maturation changes in the EEG. Matousek and Petersen (1973) conducted the first major study of age-related EEG changes. The results indicated

that delta and theta activity were dominant until the age of 4 years, with both decreasing with age. Alpha and beta activity increased throughout childhood. Matthis et al. (1980) found that with increasing age, slow wave activity appeared to be replaced by faster frequencies. As such, change in EEG frequency can be used to index the neural maturation. Among factors that might exert influence on brain function, physical activity has been found to affect several cognitive and emotional functions of adults. In addition, Shih (2003) found that delta activity was significantly negatively correlated with movement ability ( $r = -.693$ ) in preschool children. With the inconsistent findings on gender differences in the normal maturation of the EEG, the current study examined whether gender moderates the relationship between movement activity and EEG frequency in preschoolers. Sixteen boys and 15 girls, ages 5 to 5½ years, participated in this study. Each was assessed by the Basic Motor Ability Tests-Revised (Armheim & Sinclair, 1978) to determine his or her movement ability. The EEG was recorded during an eyes-closed resting condition at six electrode sites: F3, F4, Cz, Pz, O1, and O2. The cleaned EEG was fast-Fourier transformed to provide estimates for absolute power in the six frequency bands: delta, 0.5–3.5 Hz; theta, 4–7 Hz; low alpha, 7.5–9 Hz; high alpha, 9.5–12.5 Hz; low beta 13–19 Hz; and high beta 20–30 Hz. A Movement ability  $\times$  Gender ANOVA was employed on each of six electrodes for six frequency bands separately. The result revealed a significant Movement ability  $\times$  Gender interaction effect on all six electrode for the delta band. Follow-up analysis revealed that in boys, delta powers had significant correlations with performance of physical activity at F3, F4, Cz, Pz, O1, and O2 ( $p < .05$ ).  $R^2$  values range from 0.32 to 0.46. In girls there were no significant correlations with movement ability in all six frequency bands at six electrode sites. These results indicated that gender may play a role in moderating the relationship between movement ability and EEG maturation.

### **On the Structure of Timeout Calls in Basketball Games**

Lin, J-H., C-P. Yun, and Y-T. Liu. Taipei, Taiwan

The purpose of this study was to analyze within a dynamical system framework the factors influencing the timeout decisions of basketball coaches. Data used for the analysis were recorded from 9 teams (5 men's and 4 women's), a total of 98 games of the last two rounds of the Taiwan Division A Basketball tournament in the 2002 season. Frequency of timeout calls was used as the dependent variable, while the lead or lag status at timeout calls, the changing rate of score difference, and duration of the monotonic change of the score difference before the timeout called were examined as independent variables. The results show that the static lead or lag condition does not make a significant difference on the frequency of timeout calls. However, a losing streak results in a negative slope for the change rate of the score difference and implies significantly more frequent timeout calls than the positive slope condition. The duration of 1–2 minutes of the monotonic change of the score difference had a significantly higher frequency of timeout calls than durations less than 1 minute, 2–3 min, and longer than 3 min. Moreover, the interaction between the change rate and change duration show that timeout is rarely called for winning trends lasting under 1 minute; it is significantly more frequently called at 1- to 2-min durations when there is a losing trend. Further examination also reveals that the value of slopes for the change rate of score difference had a close relationship with the duration of monotonic change before timeout called. It appears that a threshold of the slope of the change rate for different change durations may be a factor in making the decision to call a timeout. In addition, the timeout availability and the remaining time of each period could also factor into the decision. Finally, an integrated and fire neuron model is suggested to describe the general dynamics of timeout calls in basketball games.

### **Does Learning Facilitate Brain Closer to Optimal Mental States? An EEG Study**

Lin, T-C., J-H. Lin, C-L. Li, Y-J. Chen, C-T. Wu, and T-M. Hung. Taipei, Taiwan

Hatfield and Hillman (2001) posit that optimal mental states associated with superior sport performance can be characterized by an efficient allocation of neural resources to deal with the task at hand. The development of neural efficiency is the result of mental adaptation to the challenge imposed by the environment. Several studies have shown that experts needed less effort to complete the same task compared to novices. In other words, experts can use a more efficient way to allocate their neural resources. The cross-sectional nature of these studies has limited our inference on the relationship between neural efficiency and practice. As such, the current study intended to examine this relationship using a longitudinal approach. Specifically, this study examined the change of EEG activity among different brain areas as a function of motor skill learning. We hypothesized that the activity of brain areas of high skill level would concentrate mainly on the areas related to the motor skill. To prove it, we designed a maze of narrow roads to compare the alpha power (8–13 Hz) of EEG data between one week's practice. The rule of this test was not to touch the sideline. We encouraged the participants to finish the task as quickly and accurately as possible. The finishing time was the criterion for evaluating whether the participants improve their motor skill. Participants were two college students and the EEG was recorded at F3, F4, Fz, C3, C4, Cz, Fc1, Fc2, P3, P4, Pz, O1, O2, Poz, Fp1, Fp2, F7, F8, Fc5, Fc6, Pc1, Pc2, Pc5, Pc6, T3, T4, T5, and T6 according to international 10–20 system. The results supported the hypotheses that the activity of brain areas at high skill level mainly focused on several brain areas. This phenomenon also supported the statement that experts use a more efficient neural resource for task execution than novices.

### **Small Changes, Big Differences: Affective Responses During Exercise of Self-Selected and Imposed Intensity**

Lind, E., R. Joens-Matre, and P. Ekkekakis. Iowa State University

Exercise intensity and adherence appear to be inversely related. Possibly this relationship is mediated by affect, as higher intensity has consistently been found to be associated with declines in affective valence (i.e., reduced pleasure or increased displeasure) during exercise. Confounding the examination of the intensity/ affect/ adherence hypothesized causal chain is the fact that most studies have imposed exercise intensity, whereas most exercise is unsupervised and the intensity is self-selected. Few studies have compared the effects of self-selected and imposed intensity, but the imposed intensity was selected in advance and therefore varied in relation to the self-selected intensity. In the present study, we hypothesized that participants would intuitively select an intensity relative to the aerobic-anaerobic transition and which would allow the maintenance of stable, positive affective valence. We also hypothesized that, by contrast, when an intensity was imposed that was even slightly higher than the self-selected level, it would be impossible to maintain a physiological steady state, and therefore positive affective valence. Twenty-three formerly sedentary women (mean age =  $43.4 \pm 4.9$  yrs; mean  $\text{VO}_{2\text{peak}} = 23.0 \pm 5.7 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ ; mean BMI =  $28.0 \pm 6.3 \text{ kg}\cdot\text{m}^{-2}$ ) participated in (a) a treadmill test to exhaustion to determine  $\text{HR}_{\text{peak}}$ ,  $\text{VO}_{2\text{peak}}$ , and ventilatory threshold (VT), (b) a 20-min session of treadmill exercise at self-selected speed (SS), and (c) a 20-min session of exercise at imposed intensity (IM), a treadmill speed 10% higher than SS. Ratings of affective valence (Feeling Scale; FS) were obtained at Min 0, 5, 10, 15, and 20. While  $\%\text{HR}_{\text{peak}}$  and  $\%\text{VO}_{2\text{peak}}$  during Min 15 and 20 of SS did not differ from VT, these were higher during IM. Likewise, although FS remained stable and positive during SS, it declined continuously and became negative during IM. These

results highlight the sensitivity of affect to minute but critical changes in exercise intensity and support the use of affect as an important criterion in exercise prescriptions.

### **Self-Help Group: The Effects of Some Social Environmental Factors on the Outcome of a Weight Control Program**

Liu, S. Institute of Sport and Leisure Education, Taiwan

The purposes of this study were to examine (a) the effect of a self-help group and nutrition and exercise group to a weight control program, and (b) the effect of social environment factors (self-esteem, knowledge, self-efficacy, and social support) to 3 weight control indices (body weight, % body fat, BMI) and 4 behavior modification indices (caloric intake, exercise frequency, night snack frequency, journal keeping per week). Thirty college student with a BMI >25 participated in an 8-week weight control program and were randomly assigned to 1 of 3 groups: control, nutrition and exercise, or self-help. Repeated measures and LSD post hoc test were used as statistical analysis to compare the differences between pre and post for the 3 weight control and 4 behavioral modification indices. In addition, hierarchical multiple regression analysis was used to analyze the significance of the social environmental factors on the weight control and behavioral modification indices. The results were as follows: (1) After 8 weeks of the weight control program, the self-help group and the nutrition and exercise group had a significant decrease (improvement) in body weight, % body fat, and BMI compared to the control group. The self-help group was even better than the exercise and nutrition group. (2) There were no significant differences in the 4 behavioral modification indices between the self-help group and nutrition and exercise group, but total explained variances from the 4 behavioral modification indices for the weight control indices in both groups were above 70%. (3) The total explained variances from the social environmental factors for the weight control indices were 80% in the self-help group, 55% in the nutrition and exercise group, and only 30% in the control group. (4) The total explained variances from the social environmental factors for the behavioral modification indices were 60% in both the self-help group and nutrition and exercise group.

### **Effectiveness of Auditory-Visual Stimuli for Learning Timing Skills by Children in a Repetitive Task**

Liu, T., and J. Jensen. University of Texas at Austin

Accuracy in the control of timing tasks has been reported to be a function of age as well as modality of presentation, with auditory stimulus being more effective for adults than visual or auditory-visual stimuli. In contrast, there are conflicting reports as to the effectiveness of auditory stimuli for children. The purpose of this study was to test the hypothesis that the auditory stimulus leads to better temporal control for both children and adults in a repetitive pedaling task. A sample of 9 children (ages 4–6 yrs) and 9 adults (22–33 yrs) were randomly assigned to either an auditory, visual, or auditory-visual stimulus condition. The visual condition consisted of viewing a computer monitor that displayed current and target speeds. Participants under the auditory condition heard different tones to indicate current and target speeds. Those in the visual-auditory group received a combination of both sensory stimuli. Participants in all conditions were told that the task was to learn to pedal at 80 rpm. The auditory stimulus led to the smallest error for adults, whereas the auditory-visual stimuli led to overall less error compared with either the visual or auditory stimuli for children during skill acquisition and transfer. It was concluded that the auditory-visual stimulus is beneficial for children as young as 4 years of age in learning a repetitive temporal task. These children used more sensory resources than adults to help them achieve a temporally accurate movement.

*Supported by National Science Foundation under Grant No. 9986221*

### **Demonstration of Time-Frequency Analysis Methods for Finger Tapping Data**

Liu, W., L. Forrester, and J. Whitall. University of Maryland, Baltimore

Finger tapping is an indicator of neurological integrity and is often used as the behavioral model in motor control experiments. Classical analysis of repetitive tapping looks at timing parameters, for example speed through average intertap intervals (mean ITI) and consistency through a standardized coefficient of variation (CV ITI). Spectral analysis, on the other hand, looks at frequency parameters (FFT). Both types of analysis are based on signal stationarity. However, mean ITI is a cumulative measure and one score of CV ITI does not inform us about the consistency of neuromotor control across taps. FFT by itself also does not address the continuous nature of a signal. We propose instead that time-frequency distribution analysis (TFD) is a useful analysis tool for nonstationary finger tapping with the advantage of integrating both domains. We measured 3D spatial position data of finger tapping with a magnetic tracking system using sensors taped to the right index fingernail. Cohen's class of time frequency analysis was used to compute the TFD of finger tapping in different conditions. Single trials that had similar ITI and CV ITI at 1.2 Hz from child and adult were selected for analysis. The adult finger tapping shows a stable and continuous frequency bandwidth over time, while the child finger tapping shows an unstable and discrete bandwidth. Neither a time-based analysis nor FFT would reveal differences between the adult and child, but from the TFD analysis we can see different control patterns at similar ITI and CV ITI conditions. This demonstrates the potential for TFD analysis as a tool to describe subtle changes based on nonstationarity in tapping, which in turn allows us to gain more information on the refinement of motor control during cyclical actions. We demonstrate the TFD technique and provide further examples.

### **The Relationship Among Goal Orientations, Motivation Climate, and Moral Reasoning in Intramural Basketball Participants**

Lochbaum, M., M. Allbright, M. Schafer, and S. Sell. Texas Tech University

Roberts' (1992) framework hypothesizing the relationships among goal orientations, motivational climates, cognitions, and behaviors were examined. The first purpose of this study was to test whether the perceived motivational climate would impact moral functioning in 336 male and 162 female intramural basketball players. The athletes were surveyed on (a) moral dilemmas assessing judgment, intention, and behavior, (b) the TEOSQ, and (c) perceptions of team motivational climate. Initial analyses pointed to several gender differences; hence separate analyses were conducted. To test our first purpose, the top and bottom quartiles were selected for both genders based on their response to the motivational climate question. Separate MANOVAs were conducted for the three items in each moral dilemma: judgment, intention, and behavior. In addition, a MANOVA was conducted for goal orientations. All the MANOVAs were significant,  $p < .05$ . In addition, nearly all follow-up ANOVAs were statistically significant,  $p < .05$ , indicating that indeed participants who perceived their team motivation climate as ego oriented endorsed lower moral judgment, intention, and past behaviors. The MANOVA for goal orientations revealed that higher ego goal orientation scores were found in the ego motivational climate compared to the task orientation climate, whereas individual task goal orientation scores were not statistically different between the two climates. The second purpose of this study was to examine the goal orientations and motivational climate of teams that received a serious violation during the season. The MANOVA that was conducted on goal orientations and motivational climate was significant,  $p < .05$ , and follow-up one-way ANOVAs revealed that serious-violation teams endorsed an ego orientation and motivational climate more so than the other

teams. No differences resulted on task orientation. The present research supported several aspects of Robert's (1992) framework.

### **Effects of State Anxiety on Temporal and Spatial Parameters Associated With Normal Gait in Healthy Young Adults**

Long, A., C. Kovacs, and E. Acevedo. University of Mississippi

The study of attentional demands during functional tasks is an emergent area that deserves further research in our discipline (Woollacott & Shumway-Cook, 2002). An elevated level of anxiety may act as an attentional demand, which may influence performance during functional activities such as walking. This current study is part of a larger, ongoing study examining the effects of increased state anxiety on functional movements in healthy young and older adults. Using a pretest/posttest design, we examined temporal and spatial gait parameters in 22 healthy young adult participants (mean age 20.05 yrs) following the presentation of a stressor. State anxiety was modified through the use of the Stroop Color word task and mental subtraction tasks between pre- and postmeasures. The following functional measures of gait were evaluated: velocity, step time, step length, single support percent of cycle, single support time, double support percent of cycle, and double support time. Physiological arousal was assessed throughout the protocol using heart rate and blood pressure responses, and perceived stress was assessed using the State Anxiety Inventory (Spielberger, 1975). Measurements of gait analysis were assessed using the GAITrite gait analysis system (CIR Systems Inc., Clifton, NJ). Increases in heart rate, blood pressure, and state anxiety were observed. Paired-sample analysis revealed significant differences in velocity,  $p = .022$ ; step length for left leg,  $p = .010$ ; step length for right leg,  $p = .020$ ; double support percent of cycle for left leg,  $p = .014$ ; and double support percent of cycle for right leg,  $p = .006$ . No significant differences were seen in measures of step time for either leg, single support percent of cycle, single support time, or double support time. These results suggest that elevated levels of state anxiety in young adults may alter normal indices of gait in this population, possibly resulting in increased balance and obstacle avoidance difficulties with changing environmental conditions.

### **Gender Differences in the Acquisition of a Novel Skill After Verbal or Visual Instruction**

Lowry, R. University of Strathclyde

Gender differences have been established in terms of cognitive abilities from adolescence onward. This study examined whether there are gender differences in preadolescents in terms of motor skill acquisition after verbal and visual modes of instruction. Participants were 96 six right-handed children (48 M, 48 F), ages 8 through 11, who were taught how to juggle, receiving verbal, visual, or no instruction. Each child was tested at two intervals, immediately following instruction (learning) and 1 week later (retention). Using a repeated-measures ANOVA, a significant interaction between group by gender,  $F(2, 90) = 9.31$ ,  $p < 0.001$ , was found in terms of the number of successful juggles performed. Post hoc Dunnett's C procedure revealed that when exposed to different forms of instruction, boys perform better after visual instruction and girls do better after verbal instruction. Both forms of instruction led to better skill acquisition than no instruction and showed that preadolescent children can acquire the same level of skill regardless of gender. These findings extend our current knowledge of gender differences. It is clear that not only are there differences in cognitive abilities but there are also gender differences in the acquisition of skill depending on the style of instruction.

### **Exploring Intrinsic and Extrinsic Motivational Differences According to Choice of Physical Activity**

Lowry, R.<sup>1</sup>, and J. Kremer<sup>2</sup>. <sup>1</sup>University of Strathclyde; <sup>2</sup>Queen's University Belfast

Participation motivation research in the domain of physical activity has typically addressed a number of demographic and contextual factors in which there are differences in key constructs. An omission from this work has been the context of the type of sport or exercise activity that participants are involved in. Using categories of individual, coactive, and interactive activities as described by Cox (2002), this study examined intrinsic and extrinsic motives using the Sport Motivation Scale (SMS; Pelletier, Fortier, Vallerand, Tuson, Briere, & Blais, 1995). A sample of 635 early adolescents, ages 12–15 years, were surveyed on their participation in physical activity outside of compulsory school-based activity. Those who were involved in interactive activities had been doing so for a longer period, at a more competitive level, and participated for more hours per week than those who were involved in coactive or individual pursuits. The results indicated no significant difference across activity groups in terms of amotivation or introjected regulation scores. Significant differences were observed for the three intrinsic motivation scales, external and identified regulation. Participants involved in interactive activities scored consistently higher across these constructs than coactive and individual participants. In addition, coactive participants reported higher scores for a number of participation motivation constructs than did individual activity participants.

### **Pressure Equals Pain? Physical Activity as a Moderator of the Stress–Health Complaints Relationship**

Lutz, R.\* , S. Sell, T. Carson, A. Ready, and M. Lochbaum. \*Baylor University; Texas Tech University

This study examined the relationships between leisure-time exercise, stress, personality, and health complaints. Recent research (Haugland, Wold, & Torsheim, 2003) found that adolescents who engage in exercise at least once a week reported fewer health complaints than those who did not exercise. The latter relationship was most evident for adolescents who reported high levels of stress. Haugland et al. noted, however, that personality types may vary between fit and unfit individuals, and that personality's effect on the relationship between stress and health complaints should be considered. Participants ( $N = 275$ ; 125 M and 145 F) were recruited from university health and fitness classes to complete the following surveys: NEO-FFI, perceived stress scale, LOT, Godin LTEQ, and a 20-item health symptom checklist (Kaplan & Camacho, 1983). The results of regression analysis indicated that perceived stress ( $\beta = .66$ ) and strenuous exercise ( $\beta = .30$ ) were significant predictors of health complaints. However, there was also a significant Stress  $\times$  Strenuous Exercise interaction. Examination of simple regression slopes showed that the stress–health complaints relationship differed according to amount of typical strenuous exercise participation. Students who frequently engaged in strenuous exercise reported similar amounts of health complaints regardless of the amount of stress they reported. Those who seldom engaged in strenuous exercise and reported high levels of stress, however, reported more health complaints than those who reported moderate or lower stress levels. Gender, stress, exercise, and the interaction term accounted for 23.9% of the variance in health complaints. Regression analysis on personality variables did not add any predictive utility to the model. Though results differ somewhat from Haugland et al.'s (2003) findings, the present study similarly suggests that exercise participation has an attenuating effect on the stress–symptom relationship.



### **Prehension: Visual and Haptic Information About Object Texture**

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Information about object texture may be obtained through visual and haptic channels (Lederman & Klatzky, 1987). Johansson and Westling (1984, 1988) demonstrated that grasping forces were higher for slippery objects like silk than for less slippery surfaces like sandpaper. It is unclear whether visual information about texture affects reach-and-grasp kinematics, or the grasping forces. Also, when visual and haptic information are discordant with respect to object texture, which one is more important for the planning and control of prehension? We hypothesized that the planning and control of prehension would be based on visual information up until haptic contact with the object. We designed an experiment to provide graphic and haptic information about object texture. Through a mirrored display, cubes were graphically represented with sides covered in sandpaper or satin. The physical objects were covered in sandpaper (50 grit) or satin, yielding a  $2 \times 2$  design, whereby graphic and haptic information were concordant or discordant with respect to object texture. The object was imbedded with a transducer to measure horizontal grasping forces, and 3D kinematics of grasping were recorded as participants reached, grasped, and lifted the 47-g, 2.5-cm cube. Kinematic results did not change as a function of the object texture to be grasped, and grasping forces varied only as a function of the actual texture of the objects grasped, regardless of the concordant and discordant graphic/haptic textures. Results are discussed relative to the other results on the effects of texture and weight on human grasping (Kawai et al., 2001; Weir et al., 1991).

### **Concurrent and Terminal Augmented Feedback Effects on Learning a Bimanual Coordination Skill**

Magill, R., and J. Porter. Louisiana State University

Research involving continuous bimanual coordination skills that require 90° out-of-phase movements (e.g., Swinnen et al., 1997) has shown beneficial learning effects for concurrent augmented feedback (CAF) rather than the typical negative learning effects reported for motor skills. The experiment reported here is an initial look at possible procedural factors that could account for the Swinnen et al. results, i.e., no additional visual and verbal augmented feedback. Participants ( $N = 30$ ) practiced a continuous 90° out-of-phase bimanual coordination skill by drawing circles inside a visible square on a computer monitor for 15 sec at a rate of 1/sec. Those who received CAF saw their drawing performance as they moved their arms, while those who received terminal augmented feedback saw their drawing performance as a static image at the end of each trial. Both groups practiced 60 trials on each of 3 consecutive days. On the 4th day they performed a 20-trial retention and a transfer test (the skill performed at an increased speed). Results showed that during practice, although both groups improved their relative phase AE, the CAF group reduced AE significantly on all 3 days while the terminal group significantly reduced AE only on Day 1. However, the two groups did not differ on the retention and transfer tests. In addition, the CAF group showed a significant increase in AE during the retention test compared to the end of practice on Day 3. This decrease in performance from practice to retention test differs from the no decrease reported by Swinnen et al., but is consistent with the more commonly reported results in which concurrent augmented feedback benefits practice performance when it is available, but negatively influences learning, as assessed on a retention test without CAF.

### **Influence of Action Word on the Control of Reaching-Grasping Movements**

Maitra, K.<sup>1</sup>, and K. Telage<sup>2</sup>. <sup>1</sup>Medical College of Ohio; <sup>2</sup>Ithaca College

Recently there has been renewed interest to study the interaction between language and motor control. Past studies revealed that silent reading of action words (e.g., LIFT or PLACE) printed on objects facilitated the action. This study examined the relationship between a spoken affirmative word (YEAH) and a reaching-grasping task in stroke survivors. Seven stroke survivors with right cerebrovascular accident (CVA) participated in this counterbalanced repeated-measures study with 4 conditions involving pronouncing "yeah" concurrently with the motor task. In 3 conditions they either (a) spoke, or (b) imagined speaking the word, or (c) did not speak or imagine the word during the task. In the other condition the experimenter spoke during the task. The sequential task consisted of reaching for (Segment 1) and grasping a cup from a tabletop, and moving it to a makeshift cabinet (Segment 2), and then returning the hemiparetic arm to the arm rest (Segment 3). Movement of the left upper arm was recorded using a search coil sensor. Kinematic parameters were extracted from movement data. One-way ANOVA revealed significantly fewer movement units, shorter movement times, and higher peak velocity in movements associated with the self-spoken condition compared to other conditions. No significant difference in kinematic variables was found among the other three conditions. The results of this study partially support earlier findings that an action-congruent word influences motor performance even in stroke survivors. However, the present study did not observe any effect of silent reading of congruent word on motor performance. Clinically, the results might serve as a baseline for developing a treatment program for stroke survivors requiring neuromotor rehabilitation by incorporating meaningful congruent action words.

### **Left-Handers' Comfort Levels for Reaching Movements in Working Space**

Mamolo, C., E. Roy, P. Bryden\*, and L. Rohr. University of Waterloo; \*Wilfrid Laurier University

Previous research in our laboratory has examined the distribution of preferred hand reaches into working space. To account for the distribution of reaches, we considered that the level of comfort experienced when making the movements might be important. Thus we developed the Comfort Rating Scale (CRS) to assess this. Participants were told which hand to use to perform a task at five positions in working space, two in left and right hemisphere and one at the midline. They then rated how comfortable the movement felt on a scale from 0 to 100. Our results with right-handers showed that movements made with the preferred hand were rated as being more comfortable, even for simple tasks performed in contralateral (left) hemisphere. Also, several differences between the hands emerged, in that the nonpreferred left hand showed greater sensitivity to skill demands and the position of the tool (Mamolo, Roy, Bryden, & Rohr, in press). In the present study, 15 left-handed adults were tested using the same procedure. Five tools were placed in an array of five positions 30 cm in front of the participant: at the midline, 45° to the left and right, and 90° to the left and right of the participant. Three tasks were performed: (1) lift the tool, (2) pantomime the use of the tool, and (3) actually use the tool. Each participant was told which hand to use, and after each movement was asked to give a comfort rating. Overall, results showed that the preferred hand was rated as being more comfortable, as we had seen for right-handers. In contrast to the right-handers, when performing the Lift task in contralateral (right) hemisphere, left-handers found this task to be more comfortable when performed with their nonpreferred right hand. This finding attests to the greater experience left-handers have with using their nonpreferred hand. More generally these results show that comfort level mediates the distribution of preferred-hand reaches in working space.

### **Rural African American Women's Physical Activity Participation**

Manning, T., and D. Whaley. University of Virginia

Combining the risk factors for inactivity of gender (female), race (African American), and living environment (rural) results in a group likely to live a sedentary lifestyle. Cultural beliefs and values also impact physical activity behavior. For example, racial identity and the role of significant others influence the value associated with PA and ability beliefs. These concepts are central to Eccles et al.'s (1983) expectancy-value theory, a model of achievement choice that has rarely been examined in adult contexts. The PA participation of 104 rural African American women from the Southeast U.S. (mean age 48 yrs; 41% inactive) was examined with regard to the influence of racial identity and social support on value toward and expectancies for PA. A multiple regression with expectancies, interest, attainment, and utility value as IVs, and PA level as the DV, was significant, indicating that 22.4% of the variance in activity level was accounted for by expectancies. The value components increased  $R^2$  but did not contribute significantly to the relationship. Three components of racial identity (connectedness, embedded achievement, awareness of racism) were then regressed on the value components and expectancies. This relationship was significant, with 18.4% of the variance in expectancies and value accounted for by racial identity. Finally, the social support measure was found to have low reliability, indicating a potential bias in the scale for this population. It was concluded that women with high expectancies for success in physical activity were more likely to be physically active, and women with strong racial identities were more likely to be high in expectancies for success and task value. From these findings, more effective physical activity programs can be developed to increase activity among rural African American women.

### **Lifting Esteem: Effects of a Strength-Training Intervention on Older Adults' Self-Esteem and its Correlates**

Martin Ginis, K.A., M.E. Jung, A.E. Latimer, L.R. Brawley\*, and A.L. Hicks. McMaster University; \*University of Waterloo

The Exercise and Self-Esteem Model (EXSEM; Sonstroem & Morgan, 1989) posits that exercise-induced changes in perceived physical competence and physical acceptance are related to changes in general self-esteem. These predictions were examined in a sample of 67 older adults ( $M$  age = 74.2,  $SD$  = 3.7) who participated in a 12-week strength-training intervention. They completed pre- and postintervention measures of self-efficacy for performing activities of daily living (ADL), appearance and fitness satisfaction (Reboussin et al., 2000), and general self-esteem (Rosenberg, 1965). Initial correlational analyses using residualized change scores confirmed that, as predicted, change in self-esteem was modestly correlated with change in ADL efficacy ( $r$  = .29), appearance satisfaction ( $r$  = .29), and fitness satisfaction ( $r$  = .28), all  $p$  < .05. In a multiple regression model with these variables, only ADL efficacy change explained significant variance in self-esteem change (adj  $R^2$  change = .07). However, a significant MANOVA followed by univariate analyses indicated significant improvements on all measured variables ( $p$  ≤ .01). Effect sizes ranged from .27 (ADL efficacy) to 1.06 (fitness satisfaction). Overall, the tenets of the EXSEM were supported. For older adults, exercise-related improvements in their perceived ability to perform multiple ADL may lead to improvements in their overall self-esteem.

### **Nicotine Effects of the Differentiated Components of Reaction and Movement Time**

Marzilli, T., and K. Willhoit. Pensacola, Florida

To further discriminate which level of the central processing stream nicotine is most likely to affect, we incorporated a basic chronometric approach to studying information

processing. This approach allowed for the independent examination of nicotine's effects on two theoretically nonoverlapping information processing stages which include both stimulus identification and response programming. The participants ( $N = 12$ ) completed two experimental sessions (Abstinent; Non-Abstinent) which were conducted one week apart. Each session comprised 3 tests. The first test consisted of abstinent baseline measures while the second and third tests were administered after smoking a nicotine or denicotinized cigarette supplied by an investigator prior to each test. Upon arriving at the lab following 12 hours of nicotine abstinence, participants began 480 trials of a simple reaction time task that comprised two stimulus intensities (high and low) and four movement distances (0, 7, 15, and 23 cm). Upon completing Test 1 the participants were given either a nicotine or denicotinized cigarette. After smoking it they began Test 2. They again completed the 480 trials of the simple reaction time task. This procedure was repeated for Test 3. Data analysis revealed that faster reaction times were elicited for the higher intensity stimulus as well as for the shorter movement distances, thus confirming that both the stimulus identification and response programming stages of the information processing model had been successfully manipulated. Furthermore, while the administration of nicotine significantly improved reaction time performance over baseline abstinent levels, this improvement was not differentially affected by the information processing manipulations. These results provide initial evidence that nicotine may not differentially affect the individual components of a simple reaction time task. Subsequent movement time analyses revealed that movement times increased as expected with the increased distances traveled; however, nicotine had no effect.

### **Evaluation of Scanning Methods in Bimanual Coordination**

Maslovat, D., S.S.D. Bredin, R. Chua, and I.M. Franks. University of British Columbia

Studies that examine the acquisition of a new coordination pattern typically involve a "scanning" procedure in an attempt to determine an individual's intrinsic coordination tendencies prior to learning, as well as subsequent changes in the coordination landscape following practice (Zanone & Kelso, 1992, 1997). The purpose of the present study was to evaluate two different methods of the scanning procedure. Scans were performed before and after 75 trials of a 90° out-of-phase bimanual coordination pattern and were compared to early and late acquisition trials. Four groups of participants performed scanning and acquisition trials using a combination of either: (a) an auditory metronome and continuous on-line visual feedback in the form of Lissajous figures, or (b) a discrete visual metronome in the form of two flashing square stimuli and terminal feedback. Analyses revealed that all groups improved their performance of the 90° pattern with practice. Comparison of early and late acquisition performance with pre- and postacquisition scanning performance revealed a difference only for the group that performed scanning trials using flashing squares but acquired the 90° task using the Lissajous figures. For this group, scanning performance did not reflect the performance level achieved late in acquisition. These results suggest that the sensitivity of a given scanning method may be influenced by its similarity to the method of acquiring the coordination pattern.

*Supported by Social Sciences and Humanities Research Council of Canada*

### **Performance Differences in Bimanual Congruent and Incongruent Rotation Tasks**

Mason, A.<sup>1</sup>, and P. Bryden<sup>2</sup>. <sup>1</sup>University of Wisconsin; <sup>2</sup>Wilfrid Laurier University

In many everyday tasks we are required to grasp and rotate objects in order to use them for some manipulative activity. The purpose of the present study was to examine how the magnitude of rotational movements affects the kinematics of unimanual and bimanual rotate-and-place tasks. Fourteen volunteers reached from a start position to grasp and trans-

port cubic objects while rotating the objects medially 45 or 90° to place them into tight-fitting targets. Unimanual reaches were performed with either the right or left hand to rotate a single object into the target. Bimanual reaches were performed with both hands to rotate and place two objects into two separate targets. For the bimanual trials, the magnitude of object rotation for both hands could either be congruent (both 45 or 90°) or incongruent (one 45° and one 90°). This resulted in a 2 Hand (Right, Left)  $\times$  2 Rotation (45, 90)  $\times$  3 Condition (Unimanual, Bimanual congruent, Bimanual incongruent) repeated-measures design. Kinematic data were obtained for the index finger, thumb, and wrist of both hands using a VisualEyez (Phoenix Technologies) 3D motion capture system. Results indicated that during the initial reach-to-grasp, and when transporting and rotating the objects, movement times were faster and deceleration times were shorter for the unimanual trials vs. the bimanual trials; however, the bimanual congruent and incongruent trials were similar. A Condition  $\times$  Hand interaction for movement time during the initial reach-to-grasp also indicated that the left hand took longer in the unimanual and bimanual incongruent conditions, but the two hands were similar for the bimanual congruent condition. Finally, for placing the object in the target, a Condition  $\times$  Angle interaction was found for movement time. This interaction indicated that for the incongruent condition, the 45° rotations took longer than the 90° rotations. These results are discussed in terms of the temporal synchronization of bimanual movements and handedness.

#### **Changes in Physical Self-Perceptions and Physical Characteristics Among Novice Abreast-in-a-Boat Participants**

McDonough, M., C. Sabiston, D. McKenzie, D. Jespersen, and P. Crocker. Vancouver, BC

*Abreast in a Boat* is a dragon boat program for survivors of breast cancer. The physical benefits of dragon boating for breast cancer survivors have been examined, but little is known about the social and psychological implications of participating in this program. This study aimed to better understand the physical self-perceptions of novice Abreast in a Boat participants, examine changes in physical self-perceptions over the first season in the program, and compare perceived physical-self changes to changes in actual strength and body composition. Fifteen novice Abreast in a Boat volunteers participated in two 45- to 60-min interviews at the beginning and end of the 3-month dragon boat season. The semi-structured interviews included discussions of physical self-perceptions and any perceived changes in physical self. Eight of these women also completed assessments of height, weight, BMI, sum of skinfolds, maximum strength, and  $\text{VO}_2$ . A content analysis of the physical self interview data indicated that the women varied greatly in the degree of change they experienced. Perceived changes were experienced in strength, endurance, general feelings of fitness, dragon boating skill, confidence, weight, body composition, and motivation to try other physical activities. Several women also discussed a sense of athletic identity as a result of their participation in the dragon boat program. Physical measures indicated that there were significant changes only in strength and  $\text{VO}_2$  over the 3-month period. While the women experienced significant changes in strength and endurance, many of them perceived changes in multiple facets of the physical self. While exercise programs for breast cancer survivors, such as Abreast in a Boat, have a positive impact on participants' physical health, they can also contribute to positive physical self-perceptions after breast cancer.

#### **Negotiating Paradox: Using Histories to Understand (Her)Stories of Body Image and Exercise Participation**

McGannon, K.R.<sup>1</sup>, and K.A. Cameron<sup>2</sup>. <sup>1</sup>University of Iowa; <sup>2</sup>University of Victoria

The relationship between women's body image and exercise is complex; exercise can be a double-edged sword for women. Some women become empowered, others feel

powerless, and others experience both empowerment and powerlessness (Markula, 1995). In addition to the theories (e.g., Social Cognitive) and methods (e.g., quantitative) predominantly used to examine body image and exercise, alternative theoretical perspectives and qualitative methods can enhance our understanding (Fox, 1997; Sparkes, 1997). Narrative inquiry/storytelling and discourse analysis was used to gain an in-depth understanding of body image and exercise participation of four female novice exercisers, ages 31–45 years. Significant others were also interviewed (husband, friends, children). Forty interviews were collected over 16 weeks (5 interviews per exerciser; 2 interviews per significant other). A praxeological mode of understanding (Bourdieu, 1981) was used as a theoretical framework. Results revealed that participants' "body-talk" was the result of related yet paradoxical discourses steeped in taken-for-granted histories. Histories included the women's past body-identities and exercise participation, and broader sociocultural histories of exercise and fitness within the context of the media, science, and the fitness industry. These histories were linked to how the women talked and felt about their bodies (i.e., body image) in the present, and in turn how this influenced their exercise participation.

#### **Evaluation of Pilot Data on Motivational Orientation of Master Athletes**

Medic, N., J.L. Starkes, B.W. Young, and P. Weir\*. McMaster University; \*University of Windsor

Over the last two decades an impressive body of literature has focused on the concept of motivation in sport. However, almost all research to date on motivation in sport has looked at the development of motivational factors up to peak performance. Only rarely (Starkes, Weir, & Young, 2003) have researchers considered athletes' motives for sustaining behaviors post peak. Master athletes represent a unique population because they typically continue to train and compete enthusiastically in an attempt to maintain a high level of performance and expertise. Thus the main purpose of this pilot study was to assess the sport motivation of Master athletes and their reasons for continuing to train and compete. A secondary purpose was to examine the reliability and validity of the Sport Motivation Scale in a sample of Master athletes. Twenty-three (16 M and 7 F, ages 42–74 yrs) Master athletes from a variety of sports were administered a survey that included demographic questions, questions from the Sport Motivation Scale (Pelletier, Fortier, Vallerand, Tuson, Brière, & Blais, 1995), and six additional open-ended questions. These athletes had competed from 1 to 43 years as Master athletes and reported training on average 9.4 hours per week. Preliminary analyses of internal reliability (Cronbach's alpha) of the Sport Motivation Scale showed that only two subscales ( $\alpha = .76$  for intrinsic motivation to accomplish things, and  $\alpha = .81$  for intrinsic motivation to know) demonstrated acceptable internal consistency. Cronbach's alphas for other subscales were lower than the minimum acceptable criterion of 0.70 and ranged from .38 to .62. In spite of limited sample size, these results seem to raise doubt about the ability of the Sport Motivation Scale to assess specific types of motivation in Master athletes. The mode was used to determine the most frequent responses to the open-ended questions. The major findings suggested that 39% of participants reported that the "joy of training and improving" motivates them the most to continue to train and compete. Also, injury was identified by 74% of them as the main condition under which they would stop training. Finally, 39% of athletes reported that lapse in motivation occurred mostly after "an injury or overtraining." Suggestions about future research and implications for Master athletics will be discussed.

#### **The Effects of Athletic Scholarships on Motivation in Sport**

Medic, N.<sup>1</sup>, and D.E. Stevens<sup>2</sup>. <sup>1</sup>McMaster University; <sup>2</sup>Brock University

The presence of rewards has been found to undermine intrinsic motivation (Deci & Ryan, 1999). This conclusion is primarily based on research conducted in nonsporting envi-

ronments. The purpose of this study was to examine perceived motivational changes resulting from the hypothetical manipulation of a reward (i.e., athletic scholarships). Differences in present motivation between scholarship and nonscholarship athletes were also assessed. Gender, life roles, and sport experience were also examined in relation to scholarship status. Basketball players from four Ontario ( $n = 70$ ) and seven U.S. Division I universities ( $n = 46$ ) were examined. All athletes completed a set of demographic questions, as well as questions from the Sport Motivation Scale (SMS; Pelletier, Fortier, Vallerand, Tuson, Brière, & Blais, 1995) which assessed their present motivation. Athletes also completed the SMS to evaluate their perceived future motivation based on a hypothetical manipulation of scholarship status. For Ontario nonscholarship athletes, extrinsic regulation (an extrinsic motive) increased with the introduction of a scholarship while the intrinsic motive to experience stimulation decreased. For U.S. scholarship athletes, the intrinsic motive to accomplish things decreased when scholarships were removed. When the two scholarship status groups were compared across present levels of motivation, U.S. scholarship males reported significantly higher levels of introjected regulation compared to Ontario nonscholarship males. Ontario nonscholarship females reported significantly higher levels of introjected regulation compared to U.S. scholarship females. U.S. scholarship athletes reported significantly higher levels of external regulation compared to Ontario nonscholarship athletes. Results offer partial support for self-determination theory. Suggestions about future research and implications will be discussed.

#### **Aiming to the Müller-Lyer Illusion: Effects on Planning and Control**

Mendoza, J., D. Elliott, J. Lyons, and D. Meegan\*. McMaster University; \*University of Guelph

Two experiments examined Glover and Dixon's (2001) planning-control hypothesis which suggests that visual illusions only affect the planning of actions, and not online control. In Experiment 1, participants viewed a tails-in, tails-out, or no-tails configuration for 1,000 ms ("preparation configuration"). An auditory tone sounded, which signaled them to rapidly move a stylus from the home position to the right vertex of the illusion. Upon movement initiation, the stimulus either changed or remained the same ("execution configuration"). Thus, on some trials the participants viewed one configuration during planning and a different one during execution. Vision was occluded 350 ms (for 25-cm stimuli) or 450 ms (for 35-cm stimuli) after movement initiation. When preparing and executing movements with tails-in stimuli, participants undershot the target to a greater extent compared to tails-out stimuli. Movements prepared with tails-in were shorter than those prepared with tails-out at peak velocity-PV, peak deceleration-PD, and movement end. As well, movements executed with tails-in were shorter than those executed with tails-out at PD and movement end. The latter results are inconsistent with Glover and Dixon's planning-control hypothesis. Experiment 2 was similar to Experiment 1 except that the participants either had 200, 400, or 600 ms of visual feedback during execution. The hypothesis was that any illusion-induced bias would disappear when the participants had ample visual feedback. With 200 ms of visual feedback, movements prepared with tails-in were shorter than those prepared with tails-out at PV, PD, and movement end. This bias was also observed at movement end with 400 ms of visual feedback, and at PV and movement end with 600 ms of visual feedback. Movements executed with tails-in were shorter than those executed with tails-out at the end of the movement under all visual feedback conditions. These results indicate that both planning and online control are biased by visual illusions.

### **Reaching in Near and Far Peripersonal Space: No Evidence for Contrasting Control Strategies**

Mendoza, M., and M. Heath. Indiana University

In a previous study (Mendoza & Heath, 2004) it was found that movement endpoints associated with reaches away from the body (i.e., far peripersonal space) were more variable than reaches toward the body (near peripersonal space). The present study sought to determine whether contrasting control strategies (feedback vs. feedforward) might account for disparity in the endpoint characteristics noted in the previous work. As a secondary research question, we examined the supposition that memory-based target information is more effectively/efficiently used when reaching in near as opposed to far peripersonal space (e.g., Previc, 1998). Participants ( $N = 4$ ) completed 800 trials to midline targets located in near and far peripersonal space in 5 visual conditions: target only, open-loop, and delays of 0, 500, and 2000 ms. The position of the limb at peak acceleration (PA), peak velocity (PV), and peak deceleration (PD) was regressed against the ultimate movement endpoint in order to infer movement control. If a movement is executed in a feedforward manner, then the position of the limb at any point in the movement trajectory should be strongly related to the ultimate movement endpoint. Conversely, if a feedback-based strategy is used, then the spatial position of the limb need not be strongly predictive of the ultimate movement endpoint. Consistent with previous findings, reaches in far peripersonal space exhibited greater endpoint variability relative to reaches in near peripersonal space. This difference in endpoint stability, however, could not be explained by contrasting control strategies; that is, our regression analysis did not show that reaching direction influenced limb control strategies. Moreover, we did not find evidence that memory-based target information is more effectively retained in near as opposed to far peripersonal space. Instead, reaching in the absence of visual input from the target resulted in a reliable accumulation of endpoint error and variability, a finding regardless of movement direction.

### **Stabilization and Destabilization of Perception-Action Patterns Influence the Self-Organized Recruitment of Degrees of Freedom**

Milliex, L. Université de la Méditerranée

An essential feature of complex biological systems is their ability to engage/disengage new degrees of freedom as a function of task requirement. In the dynamical approach to coordination pattern, the process of recruitment/suppression of new degrees of freedom (DOF) has been considered a phase transition phenomenon (Fink et al., 2000; Kelso et al., 1993). However, the question arises as to how muscular and informational constraints interact in the process of recruitment of new DOFs. This issue was addressed in the present experiment. Participants performed two unimanual synchronization tasks with an auditory metronome, consisting of either an index abduction on the beat or an adduction on the beat pattern. To modify the stability of coordination in the horizontal plane (Kelso et al., 2001), a haptic contact was provided in coincidence or counterphase with the metronome. The variables of interest were the relative phase and its variability, the number of transitions, and the recruitment rate. The results showed that the abduction pattern had a greater stability than the adduction pattern because there were fewer transitions in the former. Moreover, in the counterphased condition the percentage of occurrence of transitions was more important. In this condition, the less stable pattern (adduction pattern) was destabilized and transitions were systematically preceded by an enhancement of the fluctuations of the relative phase. Moreover, the recruitment depended on this information context. Indeed, the less stable pattern, adduction-on-the-beat, produced less recruitment than the most stable pattern. These results suggest that recruitment of DOF is a response to the loss of stability and



may be functional for maintaining a required coordination rather than being the result of the architecture of the muscle groups involved in pattern production.

### **Limiting the Recruitment of a New Degree of Freedom Changes the Stability of Perception-Action Patterns**

Millieux, L. Université de la Méditerranée

In a previous experiment, we have shown the existence of a trade-off between the stability of the perception-action pattern in the horizontal dimension and the recruitment of new degree-of-freedom (DOF) (movement in the vertical plane). Moreover, we have shown that the abduction-on the beat pattern was more stable in the horizontal dimension and produced simultaneously more recruitment than the adduction pattern. Thus, It remained to be determined whether the greater stability of the abduction pattern on the horizontal plane resulted from the recruitment of a new DOF. This issue was addressed in this experiment in which participants performed unimanual synchronization tasks, either index abduction or adduction on an auditory metronome beat. Two conditions were imposed: (1) a “free condition” in which the index finger was free to move in both the horizontal and vertical plane, and (2) a “constrained condition” in which movements were restrained to the horizontal plane of motion. The variables of interest were the relative phase and its variability, the number of transitions, and the recruitment rate. The results showed that in the free condition, the abduction pattern was more stable in the horizontal plane and exhibited more recruitment than the adduction pattern. Interestingly, in the constrained condition, the abduction pattern exhibited more phase transitions than in the free condition. Conversely, the stability of the adduction pattern remained unchanged whatever the condition. Thus, preventing the recruitment of DOF destabilized the more stable pattern in the free condition. These results suggested that the recruitment of DOF complemented order-to-order transitions as a source of coordinative flexibility. Thus, recruitment seems to be a functional self-organizing strategy for the CNS to increase the stability of a coordination task.

### **Comparing Ascending, Constant, and Descending Stimulus Velocities and Target Location on Coincidence-Anticipation Timing Performance**

Millsagle, D. University of Minnesota Duluth

The purpose of this study was to determine the effects of ascending, constant, and descending stimulus velocities by different target locations (length of runway) on coincidence-anticipation timing performance. After recruitment, 34 young men and women (ages 19–23) were randomly assigned to one of three experimental conditions. They viewed a light stimulus, traveling left to right on a runway, from a distance of 1.5 m. The criterion target locations on the runway were 42 in. (1.1 m), 63 in. (1.6 m), and 85 in. (2.2 m) to create a short, medium, and long runway condition. Three stimulus velocities were randomly presented and equally represented per target location using a curved Basin anticipation timer with the presentation rate controlled by a computer timer. The criterion visual stimulus velocities presented were 3 to 15 mph (1.3 to 6.7 m/s), 9 mph (4 m/s), and 15 to 3 mph (6.7 to 1.3 m/s) to create ascending, constant, and descending stimulus velocity conditions. Ninety trials were administered to each participant. Data for three stimulus velocities per target location was transformed into constant (CE), absolute (AE), and variable (VE) error scores. A 2-factor ( $3 \times 3$ , Target location  $\times$  Stimulus velocity) ANOVA was then performed on each of the 3 error score distributions. All main and interaction effects were found to be significant following the analysis for the 3 error score distributions. Using a Fisher's PLSD post hoc test, the descending stimulus in the long runway condition was found to yield significantly different CE, AE, and VE scores vs. all others. The descending stimulus velocity in the long runway condition impaired anticipation timing performance.

This study supported previous research that the longer the runway length and slower the stimulus velocity, the greater accuracy errors, bias, and inconsistency in predicting when the stimulus will arrive at the target area.

### **The Predictive Relationships Between Self-Efficacy, Imagery Use, and Rehabilitation Adherence**

Milne, M.I., C. Hall, and L. Forwell. University of Western Ontario

The predictive relationships between self-efficacy and either imagery use or rehabilitation adherence were examined in the present study, as well as the influence of gender, competition level, number of previous injuries, and length of time in rehabilitation on self-efficacy, imagery, and adherence. The Athletic Injury Self-Efficacy Questionnaire (AISEQ) and Athletic Injury Imagery Questionnaire (AIQ) were administered to 270 athletes (mean age 36.81) receiving physiotherapy at the Fowler Kennedy Sports Medicine Clinic (London, ON) and Regal Physiotherapy (North York, ON) during their appointments. Hierarchical regression analyses revealed that cognitive imagery predicted task efficacy,  $F(1, 268) = 4.81$  ( $R = .133, p < .05$ ), task efficacy predicted quality of exercise,  $F(1, 268) = 34.86$  ( $R = .339, p < .05$ ), coping efficacy predicted frequency of exercise,  $F(1, 266) = 23.36$  ( $R = .284, p < .05$ ), and both task and coping were predictors of duration of exercise,  $F(1, 265) = 4.85$  ( $R = .173, p < .05$ ). Analyses of demographic variables indicated that number of previous injuries successfully rehabilitated by an athlete influenced task efficacy,  $F(2, 267) = 6.13$  ( $p < .025$ ), frequency  $F(2, 265) = 7.99, p < .05$ , and quality of exercise,  $F(2, 67) = 4.33, p < .05$ . In addition, competition level affected quality of exercise,  $F(1, 264) = 7.45, p < .05$ .

### **Testing the Situational Level of Motivation in the Hierarchical Model Within Sports Classes: Examining Motivation Variability in Sports**

Model, E., and J. Todorovich. Gainesville, Florida

Motivation is a difficult concept to understand. Most agree that it guides and influences our actions, decisions, and behaviors (Deci & Ryan, 1985; Grolnick & Ryan, 1989; Ratelle, Rousseau, Vallerand, & Provencher, 2002). Yet we still understand little of how one's motivation shifts, varies, and adapts to different situations. Self-Determination Theory (Deci & Ryan, 1985) states that motivation can shift depending on three psychological needs as well as concurrent environmental influences. Vallerand (1997) expanded Self-Determination Theory into a multilevel approach he named the Hierarchical Model of Motivation. Within Vallerand's theory, situational motivation is assumed to operate on a "right here, right now" basis; however, this means that continued participation in a repeated environment (PE class, sports practices, rehabilitation sessions, smoking cessation programs, etc.) does not guarantee one's situational motivation stability. This seems illogical, as familiarity in our environment or experiences often dictates our situational expectations and reactions (Leary, 1994). Hence it seems plausible that situational level motivation may be more stable than Vallerand suggests. Thus the purpose of this study was to examine the stability of participants' situational motivation within sports classes. A total of 120 participants at a large university in the Southeast completed the Sport Motivation Scale (Pelletier et al., 1995) and the Situational Motivation Scale (Guay, Vallerand, & Blanchard, 2000), five times over a 16-week period. A repeated-measures ANOVA was used to determine the stability of motivation in the situational level of Vallerand's model. It was expected that situational motivation would be consistent across the five data collection periods, with little or no top-down influence from contextual motivation. Implications of how a person's "right here, right now" motivation can shift or become stable could impact teachers, coaches, physical therapists, and others for establishing behavior modification techniques and positive environments, and for promoting intrinsic motivation.

### **The Relationship Between Physical Self-Perceptions and Self-Esteem: Examining the Structure of the Physical Self**

Moore, J.B., and J.B. Bartholomew. Medical College of Georgia

The hierarchical structure of self-esteem has come into question recently, with researchers citing the lack of increasing effects from lower order constructs (e.g., sport competence) to higher order constructs (e.g., self-esteem). Furthermore, a hierarchical model of the physical self has not been conclusively confirmed, especially in longitudinal studies. However, it can be argued that at the subdomain level (e.g., sport competence), self-perceptions are still relatively broad. Furthermore, these perceptions may include cognitions other than perceived competence. Fox (2000) suggested that the hierarchy be extended to include measurement at greater levels of specificity. For the present study it was hypothesized that a model that expanded the earlier hierarchical structure to include cognitive facets below the subdomain level would clarify the hierarchical nature of the model. To test this hypothesis, 379 college students (81 M, 299 F, mean age =  $20.43 \pm 3.48$ ) enrolled in physical activity classes were asked to complete the Roseburg Self-Esteem Scale, the Physical Self-Perception Profile, and the Physical Self-Attribute Questionnaire. The latter is a 20-item scale to assess perceived competence, importance, certainty, and ideal-self discrepancy within the four subdomains measured by the Physical Self-Perception Profile—Strength, Conditioning, Body, and Sport. To test the hierarchical nature of the physical self with the addition of cognitive facets below the subdomain level, path analysis was employed. The new model displayed good fit with a Tucker and Lewis index of .91, a comparative fit index of .94, and a root mean square error of approximation of .07. The current findings support the potential expansion of the hierarchical measurement paradigm to include greater specificity below the subdomain level. These results will be discussed in the context of previous longitudinal studies involving this new theoretical model and implications for future studies.

### **Enjoyment of Physical Activity in Children: Instrument Validation in the MCG FitKid Project**

Moore, J.B., Z. Yin, and B. Gutin. Medical College of Georgia

Research with adolescents has demonstrated a positive relationship between participation in moderate to vigorous physical activity and enjoyment of physical activity. These findings would suggest that any intervention capable of increasing the enjoyment of physical activity might in turn increase future free-living physical activity behavior and sport participation. However, there is a lack of validated instruments for assessing enjoyment of physical activity in children that can be utilized in intervention studies. The Physical Activity Enjoyment Scale (PACES) is a 16-item scale which has been validated in both male and female college students and 8th-grade girls. The purpose of the present study was to validate the PACES to measure enjoyment in younger children. The present sample consisted of 497 third-grade students (mean age  $8.7 \pm .57$  yrs; 169 white, 328 black; 238 boys, 259 girls; 68% eligible for free/reduced school lunch) at the beginning of the fall semester. The PACES displayed good internal consistency (Cronbach's alpha = .87), item-total correlations (.33–.63). Furthermore, the factor structure was tested utilizing confirmatory factor analysis and the single factor solution was consistent with the factor structure previously reported,  $\chi^2 = 130.14$  (68),  $p < .0001$ , CFI = .97, RMSEA = .04. White children had higher PACES score than black children (63.23 vs. 59.57,  $p < .002$ ). Enjoyment was significantly correlated with task ( $r = .65$ ,  $p < .001$ ) and ego ( $r = -.13$ ,  $p < .01$ ) goal orientation, as well as perceptions of global self-worth ( $r = .33$ ,  $p < .001$ ), athletic competence ( $r = .22$ ,  $p < .001$ ), and physical appearance ( $r = .24$ ,  $p < .001$ ). However, it was not significantly correlated with BMI ( $r = .06$ ,  $p = .20$ ), self-reported physical activity ( $r = .08$ ,  $p = .08$ ), or cardiovascular fitness as assessed via a step test ( $r = .07$ ,  $p = .15$ ). These findings suggest that the

PACES is appropriate for children ages 7–10 years. However, the relationships with self-reported physical activity and physical measures of fitness or fatness are weak.

### **Relationships of Hand Preference Consistency and Simple Rhythmic Bimanual Coordination in Preschool Children**

Mori, S., M. Iteya, and M. Suzuki. Tokyo, Japan

In the integration between visual and kinesthetic information, we found that children of consistent laterality had better coordination than their inconsistent counterparts (Mori & Iteya, 2003). This could suggest that children of consistent laterality possess superior inter-hemispheric communication. The purpose of this study was to examine whether an inconsistent laterality group of preschool children influence the accuracy (absolute mean error) and stability (standard deviation) of simple rhythmic bimanual tapping (1:1), under four tempos (speed) paced by an auditory metronome. Twenty-seven preschool children ages 4 to 6 were classified into right-, left-, and mixed-hand preference groups using three tasks: throwing a ball, cutting with scissors, and writing. The children were evaluated on accuracy and stability in a bimanual tapping task such as demanding auditory-hand coordination: intermodal matching. As a result, for the right hand there were significant differences between all three groups (right-, left-, and mixed-handedness) for accuracy at both 1.5 and 3.0 Hz speed, and for stability at 2.0 and 3.0 Hz speed. The right-handed children showed superior accuracy and stability compared to other two groups. For the left hand there was a significant difference between all three groups for stability at 1.0 Hz. These results suggest that right-handed children possess superior preferred hand advantage in simple rhythmic bimanual tapping compared to left- and mixed-handed children.

### **An Investigation of the Relationship Between Cohesion and Flow State in Varsity and Novice Rowers**

Mugford, A.L., and L.K. Tennant. University of Kansas

The purpose of this study was to explore the relationship between the type and level of cohesion in competitive rowers and the interaction these characteristics have with flow state. Support has indicated that “flow” exists in team sport settings (Cosma, 1999; Jackson, 1995), and anecdotal evidence (Cantona & Fynn, 1996) suggests that interaction among team members is important in inducing and maintaining a flow state. This study utilized a cross-sectional survey design with 37 college Division I novice ( $n = 19$ ) and varsity ( $n = 15$ ) rowers who, upon informed consent, voluntarily participated by completing the Group Environment Questionnaire (Widmeyer, Brawley, & Carron, 1985) and Flow State Scale-2 (Jackson & Eklund, 2002) within 2 hours postcompetition. It was hypothesized that task and social cohesion would be positively associated with flow state and that level of ability would influence this association. Novice performers displayed a strong significant relationship between social cohesion and autotelic experience,  $r = .64$ . Varsity rowers generated a significant relationship between task cohesion and action-awareness merging,  $r = .53$ , and a moderate to strong relationship between task cohesion and global flow state score,  $r = .49$ , concentration on task,  $r = .45$ , and loss of self-consciousness,  $r = .44$ . Varsity rowers also had a significant relationship between social cohesion and loss of self-consciousness,  $r = .67$ , and a moderate relationship with social cohesion and concentration on task,  $r = .46$ . While qualitative analysis intends to shed more light on the subjective experience, findings support research that athletes must have sufficient ability for the level of challenge involved. Implications from this study highlight the importance of ability level to achieve a flow state. Further research is warranted to study the role of task and social cohesion and its relationship with team members’ achievement of optimal functioning through flow.

### **A Qualitative Examination of Imagery Use in Sport by Children Ages 7–8 and 9–10 Years**

Munroe-Chandler, K., C. Hall\*, L. Strachan, and N. Hall. University of Windsor;  
\*University of Western Ontario

Previous research has indicated that imagery use changes with age (Fishburne & Hall, 1988; Florisha, 1975). Furthermore, Kosslyn and colleagues (1990) found that imagery ability improved with age in children from ages 7 to 14 years. Although researchers have recognized the importance of children's use of imagery, very few studies have examined imagery use in young athletes. The purpose of the present descriptive study was to examine the use of imagery by young performers in a variety of sports and to examine the similarities and differences in imagery use by two age cohorts. Participants were young athletes, boys and girls ages 7–8 ( $n = 24$ ) and ages 9–10 ( $n = 28$ ). The children competed in both team and individual sports including, but not limited to, soccer, baseball, gymnastics, karate, and hockey, and competed at various levels. Four focus groups, two for each age category, were used as the method of data collection in order to discover what these young athletes were imaging. Each focus group consisted of 6–8 participants (same gender and same age cohort) and was structured to assess the four w's of imagery use identified by Munroe et al. (2000): where athletes use imagery, when they use it, why they use it, and what they are imaging. Results revealed that all athletes used imagery for rehearsing skills and strategies and for imagining outcome goals. The athletes reported using imagery for different reasons in practice vs. competition. Only the older cohort groups indicated using imagery postcompetition in order to review mistakes, and they also expressed that too much imagery could impede physical performance. Additional results are discussed in terms of gender differences of these two age cohorts.

*Supported by a grant from SSHRC*

### **Dissociation of Actual and Mental Durations in an Open Skill**

Munzert, J. Giessen, Germany

Previous studies have revealed a dissociation of actual and mental durations in performing badminton sequences. The present study specified factors that are seen to cause this dissociation. The dynamic image of the atypical flight of the shuttlecock is considered a main factor in this context. Participating in this study were 36 junior expert players. First they played a standardized sequence with a partner, then mentally simulated the rally, and finally actively replicated the paths they had run on the field. Two groups received different instructions for the mental imagery of the sequences: either to focus on the complete sequence including the flight of the shuttlecock, or to focus on the paths they had produced. A  $2 \times 3$  ANOVA for durations revealed significant differences between instructions and conditions of practice. For further analyses, constant differences between active performance and the other two conditions were calculated. It can be shown that for mental duration, the focus on the complete rally leads to longer durations than the focus on the paths in the field. For both groups there was the same trend to produce shorter durations in the active route reproduction condition. The results demonstrate nicely that especially the dynamic image of the flight of the shuttlecock leads to longer mental durations. Therefore this is considered a main factor for dissociation of actual and mental durations in badminton.

### **Exercise and Eating Behaviors Among Female Athletes in Emerging Adulthood**

Muscat, A., and B. Long. University of British Columbia

This cross-sectional study examined the relationship among hours of exercise and current level of athletic experience among female athletes across the eating-disorder con-

tinuum, in a wide range of sports. Respondents/participants in this cross-sectional study were 223 female competitive athletes, ages 19–25 yrs ( $M$  age = 20.9,  $SD$  = 1.61), attending the University of British Columbia. Thirty-eight competitive sports were represented, ranging from basketball and volleyball to ultimate and triathlon. The following research questions were posed: Are individuals with greater hours of training associated with greater disordered eating? Are individuals who compete at high level sports protected from symptoms of eating disorder? Participants completed the Eating Disorder Examination Questionnaire (Fairburn & Beglin, 1994) and a biographical questionnaire. Results and implications for research and practice will be discussed.

### **An Evaluation of the Psychometric Properties of the Coaching Efficacy Scale for American Coaches: A Validation Study**

Myers, N., E. Wolfe, and D. Feltz. Michigan State University

This study extends validity evidence for the Coaching Efficacy Scale (CES; Feltz, Chase, Moritz, & Sullivan, 1999) by providing an evaluation of the psychometric properties of the instrument from previously collected data from American high school and college coaches. Data were subjected to multidimensional random coefficients multinomial logit modeling (MRCMLM; Adams, Wilson, & Wang, 1997). Calibrating the data to the MRCMLM, as opposed to modeling raw scores, provides in-depth information on sources of misfit (Tenenbaum & Fogarty, 1998), stretches extreme scores further apart via a nonlinear transformation of raw scores to a logit scale (Smith, 2000), and estimates disattenuated correlations among latent factors. Results offered some support for the proposed internal model, the fit of observed values to expected values for the majority of items, the internal reliability of coaching efficacy estimates, and the precision of unidimensional coaching efficacy estimates. Validity concerns were observed for the rating scale structure, the precision of multidimensional coaching efficacy estimates, and differential dimensionality based on level coached and gender of the coach. Given the burgeoning role of coaching efficacy in coaching education research, that the CES is the only instrument purported to measure the construct, and the validity evidences forwarded in this study, it appears that continued use of the CES for the intended purposes is reasonable. However, users of the CES are encouraged to note the validity concerns highlighted. Developers of a revised instrument should attempt to directly address the validity concerns identified.

### **Visual Search Strategy of Soccer Players in One-on-One Defensive Situations**

Nagano, T., and T. Kato. Fujisawa-shi, Japan

This study examined differences between the visual search strategies of experienced and inexperienced soccer players in one-on-one defensive soccer play. We conducted an experiment to compare the eye movements of experienced and inexperienced players as they played one-on-one soccer defense. All played one-on-one defense against a skilled player for three attack sequences. Their eye movements were recorded and analyzed to obtain information on search order, fixation locations, fixation durations, and number of fixations. The results showed significant differences in visual search strategies between experienced and inexperienced players. Experienced players fixated more often on both the knee and hip regions of opponents than inexperienced players. This indicates that information gained from these areas was important in anticipating an offensive opponent's movements. These results characterize effective visual search strategies for experienced players in one-on-one defensive situations on the field, demonstrating that it is important for soccer players not to focus too closely on the ball.

### **The Effect of Figurative Verbal Instruction on Gymnastic Training**

Nagayama, T., K. Kitamura, and S. Saito. Sendai, Japan

The purpose of this study was to investigate the effect of figurative verbal instructions on skill acquisition during gymnastic training. Five coaches and 10 junior gymnasts (mean age 11.8 yrs) served as the participants for this study. Twenty four training sessions in which coaches instructed junior gymnasts on motor skills by figurative language were observed and recorded. Also, in-depth interview was conducted with coaches and gymnasts, and stimulating recall by VTR every training session. Interview transcripts were divided into 40 meaning units. These meaning units were regrouped into categories and two factors which were crucial for the effect of figurative verbal instructions on gymnastic training. Two factors emerging from the analysis consisted of (a) structuring network, and (b) coding. Results revealed that junior gymnasts structured a network by linking components they had already experienced, and coded the network by figurative language. In short, junior gymnasts could reconstruct many gymnastic skills as a simple network by which they could make logical images when coaches instructed them through figurative verbal instruction.

### **Visual Information Processing in Golf Putting—From the Viewpoint of Visual Search Patterns**

Naito, K., K. Takaaki, and T. Fukuda. Fujisawa-shi, Japan

Numerous tips offer advice to golfers, but they are often unsubstantiated and do not promote skill development. For example, if the saying “Keep your eye on the ball” were reliable, expert golfers would always look at the ball when putting. However, most golfers indicate that they barely pay attention to the ball. The purpose of this study was to clarify, through direct measurement of their eye movements, the scanning patterns of golfers while putting. Each participant performed 10 consecutive putts on a practice mat from a position 2 meters from the hole. Their eye movements were measured with an eye mark recorder EMR-8. Our analysis of eye movements for groups of participants revealed differences between experts, intermediates, and beginners. The intermediates fixated longer on the ball than the experts. The beginners exhibited a range of behaviors among the trials, some of which did not include any fixations on the ball. Meanwhile, experts held their eyes steady but did not fixate on the ball, but rather on a point away from the ball. Thus the visual behavior of the experts differed from what the saying advises. Our results are suggestive of the influence of the saying—when putting, experts relied on a mental image of the ball, not on visual data alone. In contrast, the intermediates and some beginners relied on visual data. Our results also suggest that, in short, the saying is not always reliable.

### **The Effects of Cerebral Palsy on the Ability to Scale Responses to Changes in Pedaling Cadence**

Newstead A.H., T.S. Pile, and J.L. Jensen. University of Texas at Austin

Cerebral palsy (CP) creates a disruption in neuromotor processes such as timing of muscle activation and the muscular forces produced. We tested the scaling ability of those with and those without CP in adjusting muscle activity to changing task demands. The usefulness of such an inquiry lies in the potential to create better training and rehabilitation protocols to expand the range of function for those persons with CP. Two adults—one with cerebral palsy (CP) and one without (Control), pedaled at 5 cadences (40–120 rpm) for 15 sec on an upright cycle ergometer at 15% predicted peak power. The muscle activation characteristics of four muscle groups were monitored: tibialis anterior (TA), gastrocnemius (Gas), quadriceps (Quads), and hamstrings (Hams). Results revealed that CP was able to

achieve all target cadences but was unable to sustain the pedaling rate at higher cadences. With the exception of the Gas, muscle activation was of longer duration for CP than Control. Coactivity was greater between TA/Gas for CP than Control. For the Quads/Hams, CP showed less coactivation compared to Control. Our findings indicate that CP had more difficulty scaling muscle activity to the task, as evidenced by proportionally greater cocontraction of the distal ankle muscles and more continuous lower extremity muscle activity. In contrast Control used a strategy of coactivation of the knee to stabilize the limb against the pedal resistance. These findings reveal differences in neuromuscular strategies for accomplishing the pedaling task. Such differences may warrant different training/rehabilitation protocols.

*Supported by National Science Foundation under Grant No. 9987221*

### **Effects of Group Characteristics in a Structured Exercise Setting on Individual Energy Expenditure Levels**

Nickel, D., K. Spink, K. Wilson, M. Bruner, J. Watson, and J. Bostick. University of Saskatchewan

It has been established that group characteristics are related to individual energy expenditure in unstructured exercise settings (Bruner et al., 2004). It was found in that study that the group characteristics of enjoyment and norms and roles were positively related to energy expenditure whereas communication and interaction were inversely related to energy expenditure. The purpose of the present study was to replicate and extend this finding to a structured exercise setting. The extension to a structured exercise was based on the fact that setting tends to moderate the relationship between social correlates and energy expenditure (Spink, 2003). Individuals who participated ( $N = 76$ ) in structured exercise programs completed a questionnaire previously used to assess group characteristics (Bruner et al., 2003) and a modified version of the MAQ (Krista et al., 1990) to assess energy expenditure. Discriminant function analysis was able to discriminate between low and high energy expenditure groups (using a median split),  $\chi^2(3) = 15.37, p < .009$ . Participants who reported high scores on norms and roles, communication and interaction, and self-identification as a group were more likely to be in the high energy expenditure group. The fact that only one of the characteristics found in this study was similar (norms and roles), one was different (self-identification), and one was in the opposite direction (communication and interaction) from the previous findings (Bruner et al., 2004) provides preliminary evidence that it may be important to account for setting in future examinations of correlates of energy expenditure.

### **Examining the Relationship Between Group Cohesion and Satisfaction in Female Sport Teams: A Multilevel Approach**

Nickel, D., K. Spink, K. Wilson, and P. Odnokon. University of Saskatchewan

It has been established that cohesion is a possible predictor of individual satisfaction in the sport setting (Spink, 1995; Spink & Odnokon, 2000). While this relationship has been established, it was done using the individual as the unit of analysis. Given the recent finding that individual perceptions of group cohesion tend to reflect shared beliefs (Carron et al., 2003), the use of a multilevel model that explicitly views individuals as nested within teams appears to be warranted. The purpose of this study was to examine the relationship between group cohesion and satisfaction at multiple levels. This was done using hierarchical linear modeling, which partitions the total variance into variance at the athlete level and variance at the team level. Female athletes ( $N = 180$ ) from 16 sport teams completed the GEQ (Carron et al., 1985) to assess cohesion, and the team integration subscale from the ASQ (Reimer & Chelladurai, 1998) to assess team task satisfaction before a team practice during the last



week of the season. Results revealed a significant ICC (.21) for task satisfaction, suggesting two levels of analysis—group and individual. The model accounting for the most variance at both the athlete and team level included GIT and ATG-T, both  $p < 0.001$ . This model explained 41% of total variance, with 78% of the variance at the team level and 32% of the variance at the athlete level being explained. These findings support the suggestion that task cohesion is related to task satisfaction for female athletes, and that this relationship should be examined at both the team and individual levels.

### **A Taxonomy of Coping Strategies Used to Manage Body-Related Concerns in Adolescence**

Niefer, C.<sup>1</sup>, K. Kowalski<sup>1</sup>, D. Stevens<sup>2</sup>, and P. Crocker<sup>3</sup>. <sup>1</sup>University of Saskatchewan; <sup>2</sup>Brock University; <sup>3</sup>University of British Columbia

Despite the vast amount of literature in the body domain, there remains a need to develop a comprehensive classification system of coping with body issues. Our goal was to develop a taxonomy that could be used to code coping strategies reported by adolescents to manage body-related concerns. This was achieved through a 9-step process which began with an integration of dimensions outlined in Ryan-Wagner's (1992) taxonomy of coping strategies and Tamres et al.'s (2002) meta-analysis of gender differences in coping. We then reviewed various coping scales as well as theoretical and empirical literature on emotion, coping, and perceptions of the body. The taxonomy further evolved as part of our larger study examining coping with social physique anxiety in adolescence during coding of open-ended self-reported coping strategies. The remaining dimensions were revised to achieve a list of coping dimensions that captured a wide range of coping strategies demonstrated by adolescents. Thirty distinct dimensions constitute the final taxonomy. This final taxonomy was tested by coding 304 strategies reported by 111 adolescents from an independent sample. Proportion of agreement after correcting for chance between two independent coders was kappa = .86. This taxonomy has the potential to assist in coding open-ended coping data in the body domain.

*Supported by Social Sciences and Humanities Research Council of Canada (SSHRC) and the Saskatchewan Health Research Foundation (SHRF)*

### **Physical Activity Outcomes of a Pilot Intervention Using SPARK Active Recreation in Elementary After-School Programs**

Nigg, C.<sup>1</sup>, J. Battista<sup>1</sup>, JA. Chang<sup>2</sup>, M. Yamashita<sup>2</sup>, and R. Chung<sup>2</sup>. <sup>1</sup>University of Hawaii at Mano; <sup>2</sup>Hawaii Medical Service Association

Almost 50% of young people ages 12–21 years are not regularly vigorously active. Keeping students engaged in physical activity (PA) after school can improve health and decrease delinquency, risky health behaviors, and social problems that are likely to occur during after-school hours. Therefore the pilot project's purpose is to promote and increase regular, moderate, and vigorous PA using the Sports, Play, and Active Recreation for Kids-Active Recreation curriculum (SPARK-AR) among students in Grades 4–6 in an after-school program. Six schools received the SPARK-AR 2-day training and equipment and were asked to incorporate SPARK-AR 3 times/week for 45 minutes, while 6 other schools were assigned to the wait list control. The System for Observing Fitness Instruction Time (SOFIT) and a survey assessing physical activity were conducted pre- and postintervention. In all, 80% completed the follow-up survey (237 intervention, 48.9% girls) and 187 control (46.5% girls). Based on SOFIT, intervention schools increased time spent on game play and decreased class management compared to control schools,  $p < .05$ . However, this did not translate to differences in the amount of activity observed during the after-school program.

Survey results revealed a greater increase in strenuous activity for the intervention group: 3.71 d/wk ( $SD = 2.20$ ) – 4.52 d/wk ( $SD = 2.05$ ), compared to the control: 4.36 d/wk ( $SD = 2.21$ ) – 4.50 d/wk ( $SD = 2.03$ ),  $p < .05$ . There were no differences in moderate activity or time spent watching TV/playing video games by group or time. Both groups significantly increased mild activity from baseline to follow-up. Positive results are documented for lesson context and frequency of strenuous leisure-time physical activity with several areas of improvement noted, most significantly continued support of group leaders to maintain enthusiasm and motivation to deliver SPARK-AR.

*Funded by Hawaii Medical Service Association, an Independent Licensee of Blue Cross and Blue Shield*

### **Where, When, and How: Basic Components of Dance Imagery**

Nordin, S.M., and J. Cumming. The University of Birmingham

Despite large advances in our understanding of imagery use in sport and exercise, little scientific work has been done in the area of dance imagery. Consequently, in-depth semi-structured interviews were conducted with 14 male and female professional dancers from a variety of dance forms. Interviews were based in the 4 W's framework (Munroe et al., 2000), which means exploring where, when, why, and what imagery dancers use. The recorded interviews were transcribed verbatim and content analyzed with NVivo 4.0. Both inductive and deductive procedures were used. In this presentation we describe when and where, and also how professional dancers use imagery. *When* refers to the timing of imagery use. Nine higher-order themes emerged under this heading: before, during, and after (1) specific movement; (2) class or rehearsal; (3) performance; and (4) teaching. Furthermore, (5) anytime or all the time; (6) in particular dance types; (7) in specific instances; (8) at certain times of day; and (9) in rehearsal, performance, and holiday periods. The theme "imagery use during actual movement" is an interesting finding which warrants further research. *Where* refers to the location of imagery use and yielded four higher-order themes: (1) at home; (2) in dance settings; (3) in other places; and (4) anywhere. Dancers also mentioned when and where not to use imagery, indicating that they perceived the facilitativeness of imagery use to vary with time and place. *How* dancers use imagery refers to the processes they employ in order to make imagery effective. Five higher-order themes emerged: (1) look for, get, or create images via metaphors and pictures; (2) retrieve specific memories; (3) create triggers; (4) watch others and from this generate a kinesthetic feel; and (5) in various ways interpret images. Similarities and differences between sport, exercise, and dance imagery will be discussed, and suggestions for future imagery research given.

### **Minimal Essential Information Underlying Skilled Perception in Soccer**

North, J., N. Smeeton, A.M. Williams, and N. Hodges. Liverpool John Moores University

The aim of this study was to identify the information used by skilled and less skilled soccer players to recognize patterns of play. The ability to recognize patterns of play is the strongest predictor of anticipation skill in soccer (Williams & Davids, 1995). We conducted a series of studies to address this issue using a repeated-measures design and various display manipulations. In Study 1, the recognition paradigm was employed to confirm that skilled soccer defenders are faster than their less skilled counterparts at recognizing structured sequences of offensive play presented via video. In Study 2, a novel spatial occlusion technique was employed to erase two central attacking players and their corresponding defensive markers from each action sequence. A significant decrement in performance was observed for both skill groups when viewing the occluded trials compared with the non-

occluded control condition; most important, the main effect for skill reported in Study 1 was no longer present, implying that skilled players were reliant on information from these players to facilitate recognition performance. In Study 3, the film clips were converted into point light display (PLD) format and the recognition test was repeated. A strong expertise effect in favor of skilled soccer players was observed. Since the main effect for skill was apparent when viewing both PLD and video footage, the suggestion is that experts use the relative motions between players as a means to gather structure from a display.

### **The Eye Movements of Basketball Players in a Fast Break Situation**

Ochiai, Y., T. Kato, and T. Fukuda. Fujisawa-shi, Japan

The objective of this study was to identify the differences in visual search strategies between experts and novices while playing basketball. The participants were 4 experts and 2 novices. The game situation created was 3 offensive players against 1 defensive player. Participants dribbled the ball through the center of the court while 2 teammates ran parallel on both sides of the dribbler. Participants could pass the ball right or left. Their eye movements were measured and analyzed in this particular situation. Experts anticipated the movement of the defensive player. At the same time, they were capable of predicting the movements of the two teammates while dribbling the ball. Experts were able to judge where to pass the ball in accordance with the anticipated movement of the defensive player, whereas the eye movements of novices focused on the ball. Thus the right and left teammates were hardly seen by the novice dribbler. The novice dribblers were able to consider the teammates on the right and left only after the dribblers decided to pass the ball for the first time. These results indicate that experts always consider every space and view the entire court. On the other hand, novices tend to fix their eyes on a limited object such as the ball or pass receiver and are not capable of capturing bigger fields of view by fully utilizing the peripheral visual properties.

### **The Energy-Minimization Bias in Simple Aiming Tasks**

Oliveira, F.T.P., and D. Goodman. Simon Fraser University

Scientific as well as anecdotal evidence strongly suggests that humans tend to undershoot targets in rapid aiming tasks. Some researchers such as Elliott and colleagues have argued that, at least partially, this undershoot bias can be explained by an energy minimization mechanism; the intuitive idea is that by moving a shorter distance, one would be expending less energy. If that is the case, then by performing a task in which overshooting a target would be less energy costly, participants should present an overshoot bias. In order to test this we used two ballistic aiming tasks: the first was a simple throw of a slider to a criterion location in a linear positioning device. The second was an assisted version of the same task, which was designed to have overshooting be less energy-consuming than undershooting. Twelve participants performed 200 trials of each task with the order being counterbalanced. Constant error was measured in millimeters and averaged over 8 blocks of 25 trials for each task. A task main effect and a Block  $\times$  Task interaction (both  $p < .01$ ) indicate that participants performed significantly different in each task, demonstrating a tendency to undershoot in the nonassisted task and overshoot in the assisted task. The results support the notion that humans benefit from the inherent mechanics of the system involved in the motor tasks they engage in, and self-regulate the strategies employed by "seeking" the easiest and least energy costly solutions to motor problems.

### **KR-Delay Interval Effects in the Acquisition of Positioning Tasks at Different Complexity Levels**

Palhares, L., G. Lage, M. Vieira, H. Ugrinowitsch, and R. Benda. Belo Horizonte, Brazil

The KR-delay interval is necessary for intrinsic feedback processing, in which sensory information is fundamental in the development of error-detection. The present study consisted of two experiments that verified the role of the KR-delay interval in the learning of positioning tasks at different complexity levels, characterized by different movement sequences. Thirty-six participants were randomly distributed in three groups ( $n = 12$  per group) in each experiment: a no KR-delay interval group (G1); a 3-sec KR-delay interval group (G3); and an 8-sec KR-delay interval group (G8). All groups practiced 60 trials in the acquisition phase, consisting of transporting 3 tennis balls between 6 containers in the same box in the target time (2.7 sec) in two movement sequences, one for each experiment. The transfer (T) and retention (R) tests with the same new sequence and target time (2.3 sec) were applied 3 and 18 minutes after the end of the acquisition, respectively. The two-way (3 Groups  $\times$  12 Blocks) ANOVA was used in the analysis of acquisition, and another two-way (3 Groups  $\times$  5 Blocks) ANOVA was used in the analysis among the last block of acquisition and test blocks. In the first experiment, ANOVA detected significant difference on the Group factor in tests,  $F(2, 33) = 3.75, p = 0.034$ . Tukey's test revealed differences between G3 and G1 ( $p = 0.031$ ) in both T and R ( $p = 0.0001$ ) as well as between G1 and G8 ( $p = 0.0001$ ) in the second block of T. In the second experiment, ANOVA detected significant difference on Block factor in acquisition phase,  $F(11, 22) = 17.51, p < 0.001$ , and tests,  $F(4, 8) = 30.03, p = 0.00007$ . The results indicated that the learning of the task with lower complexity was affected for the KR-delay interval and suggest that the KR-delay interval is an important variable in the motor learning process.

### **Learned Movements Are Hard to Relearn: Built-in Resistance in Re-learning Movements**

Panzer, S., and F. Naundorf. University of Leipzig

The main purpose was to study effects of relearning a motor task when an existing motor task has to be modified. Often these modifications are quite subtle, such as changes in equipment for automobiles, airplanes, or sports equipment. Still, performers have to relearn the fairly complex coordination of a previously learned motor skill. Here the question arises as to whether previous learning impairs or improves relearning. To answer this question, we conducted two experiments using a proactive interference design. Relearning is characterized by learning a previous Task A and then relearning and recalling a Task B. In Experiment 1, we assigned 27 participants to one of three treatment conditions, termed AABB, -ABB and --BB. The task was a gross motor skill, a vertical jump, whereby participants had to scale a force parameter under task condition A and/or B. Each letter symbolizes a testing session with 100 trials. Testing sessions were separated by 48 hours. Analysis shows positive transfer (AABB 20%; -ABB 29%); but in a delayed retention test, proactive interference (PI) in recalling Task B can be observed. Experiment 2 related to the question of persistence of PI during the learning of Task B. Twelve participants were assigned to one of two treatment conditions: ABBB and -BBB. A further testing session of Task B was implemented. The findings from Experiment 1 could be partially replicated. Motor transfer was 30%. Further results show that learners of the ABBB condition can adapt to Task B during the testing session. This adaptation, however, was significantly attenuated in the next testing sessions of Task B. PI is still persistent. Learning Task B did not "wash out" the effects of the force parameter learned during the phase of acquisition of Task A. In all, the results of both experiments suggest that previous learning induces a built-in resistance to

relearning, even if the modifications between the tasks are quite subtle. Learned movements are hard to relearn.

### **Mechanisms of Force Overshoot in Rapid Isometric Force Production**

Park, J-H., and G. Stelmach. Arizona State University

Studies on both movement and isometric force production indicate that a high acceleration of force exerted by the muscles to produce a rapid and accurate final force depends on the properly specified activation level and timing between agonist and antagonist muscles. Thus it is assumed that if either (a) the nervous system inappropriately specifies the rate of initial EMG rise or burst intensity, or (b) the antagonist muscle untimely counteracts the rapidly rising EMG burst of the agonist muscle, a larger final force than the desired level will result in overshooting the target. In fact this type of target overshoot is prominent in most tasks involving rapid responses, but it has received relatively little attention. Therefore the purpose of this study was to identify the mechanisms of force overshoot (FO) during rapid force production under an isometric condition. Ten neurologically normal participants were asked to produce a single uncorrected pulse force over different force amplitudes using their right arm to determine whether the magnitude of FO is affected by different force levels at a variety of high speeds of force production. It has been proposed that the force variables and intensities of muscle activity are usually preprogrammed by the CNS and scaled with force amplitude during rapid force production. It was thus hypothesized that the magnitude of FO would be a function of force amplitude. In addition, it was also expected that there would be positive correlations between EMG parameters and the magnitude of FO. The results showed that the magnitude of FO and intensity of EMG activity increased with force production speed. For 8 of the 10 participants, however, the absolute value of FO remained unchanged with increases in force amplitude for a given speed, while EMG parameters were modulated with changes in force amplitude. Thus the invariance in magnitudes of FO across different force amplitudes and the magnitudes' low correlations to EMG parameters suggest that intrinsic properties of the muscle system, rather than a central program, have a significant influence on the overshooting phenomenon.

### **Task Switching Effects on Movement Planning and Online Control**

Parry, T., J. Shea, and J. Fairbrother\*. Indiana University; University of Tennessee Knoxville

The cost of switching between two tasks can be characterized by a performance decrement compared to performing either task separately. This difference is referred to as the task "switching cost." Shea, Fairbrother, and Parry (2003) demonstrated switch costs in the motor domain. However, there has been no study on the effect of task switching on processes associated with response planning and the online control of task performance. The purpose of this experiment was to investigate the effects of task-switching practice on the planning and online control of a simple motor task. Participants performed 72 trials across 4 practice phases. Each practice phase consisted of 18 trials on each of two 5-segment button pressing tasks (Task A and Task B) in random sequence. Mean reaction time (RT) and movement time (MT) measures were computed for blocks of 3 trials for Task A performance. RT was considered a measure of response planning processes, and MT was considered a measure of online control processes. Two separate  $4 \times 3$  (Practice phase  $\times$  Trial block) ANOVAs with repeated measures on both factors were used to analyze RT and MT measures. These analyses showed significant effects for practice phase and trial blocks, as well as for the interaction of practice phase and trial blocks,  $p < .05$ . Follow-up analyses revealed that RT decreased across Practice Phase 1, but reached asymptote after this phase and remained constant for Practice Phases 2, 3, and 4. In contrast, MT continued to decrease

across Practice Phases 1 and 2, but reached asymptote for Practice Phases 3 and 4. These findings may indicate that processes associated with response planning are less perturbed than those associated with movement control during task switching. This interpretation differs from that of prevailing theorists who believe task switching is most disruptive to processes associated with response planning (Allport, Styles, & Hsieh, 1994; Rogers & Monsell, 1995).

### **Effects of Augmented Information Timing and Repetition Distribution in Learning Novel Typographical Script**

Patterson, J., and T. Lee. McMaster University

In a recent experiment Patterson and Lee (2003) examined the acquisition and retention of novel typographical script (e.g., Graffiti script) with a factorial combination of information load (1- or 3-symbol recall) and temporal placement of a motor solution either before (proactive) or after a written attempt (retroactive). The retention findings revealed that, regardless of information load or Graffiti/English script similarity, providing a motor solution retroactively facilitated motor planning time (e.g., RT) and superior recall fluency compared to proactively-provided solutions. This retention advantage occurred despite the temporal delay of intervening practice trials before having the opportunity to retrieve an updated motor plan from memory in the retroactive conditions. Thus the purpose of the present experiment was to examine whether massed or spaced repetitions of the augmented information would facilitate either the proactively or retroactively presented solutions. Participants ( $N = 28$ , with 7 per group) practiced various Graffiti script on a Palm Pilot simulator in response to a recall prime in one of four factorially-arranged groups. Similar to the previous experiment, the cognitively effortful retroactive condition facilitated superior recall fluency and consistent motor planning in the retention period, regardless of Graffiti/English script similarity or whether the repetitions were massed or spaced. These findings suggest that practice factors leading to cognitively effortful retrievals of motor plans from memory are effective in facilitating the retention of novel typographical script, independent of practice trial format, Graffiti/English script similarity, or information load (Patterson & Lee, 2003).

### **The Reciprocal Relationship Between Team Efficacy and Team Performance in Women's Collegiate Ice Hockey**

Payment, C.A., N.D. Myers, D.L. Feltz, and C.B. Duffy. Michigan State University

A limitation of the literature on collective efficacy (CE) and team performance (TP) is a paucity of evidence to substantiate an assumed reciprocal relationship between CE and TP across time (Gully, Incalcaterra, Joshi, & Beaubien, 2002). This study examined the reciprocal relationship between CE and TP in women's college ice hockey on weekends when the opponent was constant for Friday and Saturday games. The CE of 243 athletes nested within 12 teams was assessed prior to 108 weekends or 216 games across teams (range = 7 to 12 weekends or 14 to 24 games per team). Principal component analysis (PCA) provided evidence of the unidimensionality of the CE data. Consensus analyses demonstrated that team members held mostly homogenous beliefs about their team's ability to succeed against a specified opponent. CE data were calibrated to the Rasch rating scale model to produce athlete-level measures. These logit-based measures were aggregated to the team-level for each game. Official game statistics were subjected to a PCA, and evidence of the unidimensionality of the selected TP indicators—goal difference, shots on goal difference, percentage of shots stopped, scoring percentage, and percentage of penalties killed—was observed. Component scores were used as the TP measure for each game. Measures were subjected to hierarchical linear modeling. The average influence of Satur-

day collective efficacy on Saturday performance was moderate and positive after controlling for Friday performance. The average influence of Friday performance on Saturday collective efficacy was small and positive after removing the influence of Friday collective efficacy from Friday performance. These findings, as well as aspects of the methodologies that produced them, advance the literature on reciprocal relationships between collective efficacy and team performance across time in several ways.

### **Direct Measurement of Punch Force During Two Professional Boxing Matches**

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Despite considerable research into boxing, surprisingly little is known about the fundamental physics of forces delivered in a boxing match. Most previous punch force estimates were obtained from laboratory studies in which an experienced boxer struck an inanimate object. This paper presents the first direct measurement of punch force in professional boxing matches using the *bestshot* System™, a proprietary system that records the force associated with punch impact. Four boxers wore boxing gloves incorporating the *bestshot* System in two professional boxing matches, one junior lightweight (4 rounds) and one heavyweight (6 rounds). The force of each delivered punch was measured across both bouts. Mean punch forces delivered were 981.6 Newtons for junior lightweight boxers and 1,111.6 N for heavyweights. In each bout the boxer delivering the greater cumulative force won by decision. These measurements, the first direct measurement of punch force in professional boxing matches, are considerably less than those found in laboratory demonstrations, and likely reflect the dynamic nature of the ring. The ability to monitor forces delivered and received could provide a valuable tool in the training of boxers at both the amateur and professional levels. The system yields an effective tool for measuring punch effectiveness and can be used to help trainers identify strengths and weaknesses of technique and areas that need improvement. In judging, use of this system can provide an objective measure of punch force to complement existing judging criteria. The *bestshot* System has potential safety benefits for boxers as well, as it may be used to address the long-term question of health issues related to boxing.

### **The Effects of Cerebral Palsy on the Ability to Scale Responses to Changes in Pedaling Resistance**

Pile, T.S., A.H. Newstead, and J.L. Jensen. University of Texas at Austin

Neurological disorders such as cerebral palsy (CP) affect neuromotor processes, and therefore muscle force regulation. To design effective motor skill interventions aimed at improving neuromuscular functioning, we must first understand the ability of individuals with CP to adjust to changing task demands. The purpose of this pilot study was to describe the ability of an individual with CP vs. a control participant (Con) to scale muscular forces during pedaling at different workloads. Data collected during 15-s trials were analyzed to determine participants' accuracy in performing the goal cadence of 80 rpm and timing of muscle activation relative to the crank cycle at 10% and 15% of predicted peak power (PPP). CP was less successful than Con in achieving the target cadence at both 10% PPP ( $87.1 \pm 3.6$  vs.  $80.7 \pm 1.1$  rpm) and 15% PPP ( $87.1 \pm 3.0$  vs.  $80.5 \pm 0.9$  rpm). Activation duration of TA, Gas, and Ham increased with increasing resistance for CP while only Quad and Ham duration increased for Con. Coactivity of RF/Ham decreased for CP (22.1 to 14.6% of crank cycle) but increased for Con (30.7 to 41.2%) with increased resistance. Coactivity of TA/Gas increased for CP (2.7 to 16.8%) but decreased for Con (19.2 to 0%) with increased resistance. Joint stiffening strategies to accommodate increasing workloads,

evidenced by coactivity of opposing joint muscles, differed between participants. With increasing resistance, CP changed from a knee- to an ankle-stiffening strategy of applying force to the pedal whereas Con switched from an ankle- to a knee-stiffening strategy. Differences in the ability to scale and muscle-specific methods of scaling forces in response to changing task demands between individuals with CP and those without must be considered when designing interventions to improve motor skills.

*Supported by National Science Foundation under Grant No. 9986221*

### **The Effects of Practicing a Golf Putting Task Moving Along the Contextual Interference Continuum**

Porter, J., and R. Magill. Louisiana State University

Since the Magill and Hall (1990) review of the contextual interference (CI) effect, most of the research has focused on comparing fixed levels of CI such as blocked or random, or modified levels such as serial to determine which level of CI is best for skill learning. Based on recommendations in the Magill and Hall review, a new form of practice schedule involving a gradual increase of the amount of CI during practice is examined. The hypothesis is that practicing with gradual increases of CI will lead to better performance later in practice than a random practice schedule, and to better performance on retention and transfer tests than both the blocked and random groups. Participants ( $N = 60$ ) were college-age novice golfers who practiced a golf putting task in either a blocked, random, or increasing CI practice schedule for 81 trials. Those in the increasing group practiced the first 27 trials in a blocked schedule followed by 27 serial trials and concluding with 27 trials of random practice. During acquisition they putted from three distances (3 ft, 4.5 ft, 6 ft) in line with one another toward the same target. After a 24-hr period they returned and completed both a 20-trial retention and a transfer test (putting from 2 new locations that varied in distance and angle to the target). Although results showed there were no statistical differences between groups during the practice trials or retention and transfer tests, the increasing group consistently performed better than both the random and blocked groups during practice trials and the retention and transfer tests. Although statistical significance was not achieved in this study, the results suggest that further research is warranted to investigate the hypothesis that practicing a motor skill according to a schedule that progressively increases the amount of CI can be beneficial for a novice learner.

### **The Ecological Rationality of the Hot Hand Belief**

Raab, M. University of Flensburg

In sports the hot-hand belief (greater chance to hit a ball after two hits than after two misses) is believed to be a fallacy because there is no dependence between successive events of an individual player or team performance. Research indicates that the belief is only based on a misperception of random sequences. New questions are presented in which the benefit in the hot hand behavior that is based on a false belief results in better allocation decisions of players. From an ecological rationality perspective, we will extend recent simulations which show that a belief in the hot hand can result in better allocation decisions of playmakers toward an ecological structure of sport decisions and allocation decisions in different sports to predict when specific allocation strategies will fail and when they will succeed. Five studies showed that the stability of the belief in the hot hand can be altered by context (Study 1 and Study 2). Sequences of hits and misses are not necessarily independent (Study 3). Coaches can detect base rate changes precisely in the same player (Study 4). And the hot hand behavior changes in environments in which the belief in the hot hand is costly and in which it is beneficial (Study 5). It can be concluded that the ecological rationality of the hot hand belief is a good framework for theoretical, empirical, and practical considerations.



### **Assessing Differential Learning From Modeling and Imagery Interventions Using Latent Growth Curve Models**

Ram, N.<sup>1</sup>, P. McCullagh<sup>2</sup>, and S. Skaling<sup>3</sup>. <sup>1</sup>University of Virginia; <sup>2</sup>California State University Hayward; <sup>3</sup>Alaska

Across a wide variety of physical activity settings and skills, both imagery and modeling have been found to be effective interventions. However, little is known about how these changes manifest over time. An experimental protocol was used to examine differences the patterns of learning that may occur with such interventions. In a  $2 \times 2$  crossed design, 41 novice female weight trainers received four modeling, imagery, combination, or control interventions between squat lift performances. Previous work (e.g., McCullagh & Ram, 2000; Skaling & McCullagh, 1993) noted differences in level of performance between groups, with modeling and combination groups performing at higher levels than imagery and control groups. In the present analysis, latent growth curve models were used to examine differences in performance *changes* across 8 trials. Groups differed in their patterns of improvement only immediately following the first intervention. Thereafter, all groups showed parallel increases in performance. Specifically, participants who received modeling interventions showed substantial increases in performance compared to other participants after the first intervention. Subsequent interventions did not affect the changes in performance differentially. Implications are that only a single exposure to modeling may be needed to derive the benefits of observational learning. Furthermore, because the pattern of learning continues in similar fashion for all individuals after initial exposure effects, individuals who do not receive modeling remain at a disadvantage.

### **Effects of Peppermint Odor Administration on Augmenting Basketball Performance During Game Play**

Raudenbush, B., J. Smith, K. Graham, and A. McCune. Wheeling Jesuit University

Previous research indicates that inhaling peppermint odor before and during athletic activity increases strength, speed, and endurance. It has also been found to reduce fatigue, perceived effort, and perceived frustration, and increase levels of vigor and motivation. However, assessment of peppermint odor efficacy has yet to be performed during actual physical game play. The present study was designed to assess whether the degree to which athletes inhale peppermint odor affects such aspects as motivation, energy, fatigue, reaction time, confidence, and performance during the course of a basketball season. Male and female Division II basketball players were provided with a peppermint inhaler (Peak Performance<sup>TM</sup> Sports Inhaler<sup>TM</sup>) for use during practice and game play. Level of inhalant use constituted group composition for data analysis. Higher levels of inhalant use were associated with increased motivation, energy, speed, alertness, reaction time, confidence, and strength. Levels of fatigue and frustration were lower in the high-use group. In addition, athletes' ratings of their competitive advantage over opponents and ratings of overall performance were enhanced. Implications are particularly salient in regard to augmenting a variety of factors related to athletic performance using an all-natural, nonpharmacological ergogenic aide.

### **The Influence of Workspace Location on the Kinematics of Seated Reaching in Persons With Hemiparesis**

Reisman, D., and J. Scholz. University of Delaware

Reaching for objects in a variety of locations in our environment is a goal-directed, functional task that the average person completes many times a day, yet one that is often difficult for persons following a stroke. This study investigated the influence of workspace

location on the kinematics of seated reaching movements in persons with right-sided hemiparesis following a stroke. **Methods:** Retro-reflective marker arrays were placed on the participants' upper extremity and trunk (involved side for those with hemiparesis and matched side for healthy persons) to record arm and trunk motion with a 6-camera Vicon (Oxford Metrics, UK) motion measurement system. Participants performed reaching movements to two target distances: 90% arm length (near) and 160% arm length (far), at two locations: ipsilateral and contralateral to the reaching arm. **Analysis:** Dependant measures: (a) Using a mathematical model, we partitioned the inter-trial variability of 16 joint angles into two components: (i) joint variability leading to a consistent hand path from trial to trial (i.e., GEV, goal-equivalent variability); and (ii) joint variability leading to an inconsistent hand path from trial to trial (i.e., NGEV or non-goal-equivalent variability), and (b) the actual variability of the hand's movement path. **Results:** Participants with hemiparesis demonstrated a smaller normalized difference between GEV and NGEV than the healthy control group, but only when reaching to the far, ipsilateral target,  $p < 0.005$ . The actual variability of the hand's path was also greater for those with hemiparesis when reaching to both far targets,  $p < 0.05$ . **Conclusions:** Persons with hemiparesis appear to have the greatest difficulty coordinating their joints to achieve a consistent hand path when reaching beyond arm's length (utilizing trunk motion) and toward the hemiparetic side. This conclusion was supported by the actual variability of the hand's path.

### **Moderators of the Exercise Intention and Expectation Relationship**

Rhodes, R.<sup>1</sup>, and D. Mathson<sup>2</sup>. <sup>1</sup>University of Victoria; <sup>2</sup>Malaspina University College

Intention is often theorized as the proximal determinant of one's behavior, but Warshaw and Davis (1985) have demonstrated that commonly used intention measures often assess behavioral expectation more than behavioral intention. They theorize that expectation takes other factors into consideration over intention, such as anticipated fluctuations in the commitment to the intention and perceived behavioral control (PBC)-intention interactions. Some research has provided indirect evidence for this theorizing, but no study had directly tested this proposition. Therefore the purpose of our study was to examine potential moderators of intention and expectation relations in the exercise domain. Participants were 241 undergraduate students ( $M$  age = 20.42 yrs) who completed measures of intention, expectation, commitment to their intentions, and the theory of planned behavior (TPB). Regression analysis testing interactions,  $F_{\text{change}}(2) = 11.12$ ;  $p < .01$ , demonstrated that individuals with low intention commitment ( $r^2 = .66$ ) and low PBC ( $r^2 = .71$ ) had divergent intention/expectation relationships compared to individuals with medium and high levels of intention commitment ( $r^2 = .90$ ) and PBC ( $r^2 = .89$ ). Dependent  $t$ -tests of intention and expectation means across levels of high, medium, and low PBC and intention commitment converged on the same finding ( $p < .05$ ,  $d > .20$ ). Finally, a structural equation model using TPB constructs and intention commitment to predict the expectation/intention discrepancy identified intention commitment ( $b = .17$ ,  $p < .05$ ) and PBC ( $b = .28$ ,  $p < .05$ ) as the key predictors. Based on these results, we recommend that differences between intention and expectation items be taken into account in future theory and research.

### **Frequency of Knowledge of Results and Motor Learning in Persons With Mental Retardation**

Rice, M.<sup>1</sup>, and H. Hernandez<sup>2</sup>. <sup>1</sup>Toledo, OH; <sup>2</sup>Pemberville, OH

It has been well established that feedback plays an important role in acquiring and retaining motor skills. Most research on normal populations suggests that less frequent knowledge of results (KR) is more beneficial for the retention of motor skills. However, it is not known whether this is true for special populations, for instance populations with mental

retardation (MR). This study examined the effect of high vs. low frequency KR in 16 adults with MR compared to 16 age- and gender-matched average individuals. Using a two-phase design with an acquisition phase and a retention phase, we measured performance in a computer-based motor skill task in terms of absolute error. There were 30 trials in the acquisition phase and 10 trials in the retention phase. There was a 10-min filled break between the two phases. Participants from each group were randomly assigned to a 100% KR group or a 50% KR group. Although those with MR performed with less accuracy overall, the performance of the 50% KR conditions from both populations demonstrated greater accuracy than the 100% KR conditions from both populations in the retention phase. Therefore, in terms of a reduced KR regimen, the performance of the MR population was not unlike that of the average population. These results suggest that, as has been found in the average population, feedback that is too frequent can interfere with learning and retention of motor skills for individuals with MR. To better understand efficient learning strategies for the MR population, more research is needed to explore this and other KR practice schedules that have already been well studied with average populations.

### **Time Course Analysis of Closed- and Open-Loop Grasping Müller-Lyer Illusion**

Rival, C., and M. Heath. Indiana University

Size-contrast illusions have been shown to influence perceptual estimates of object size; however, there remains much debate as to whether visual illusions similarly influence grasping. The goal of the present study was to determine whether the visuomotor system might resolve the context-dependent nature of a pictorial illusion very early—if not immediately—following the onset of a grasping response (i.e., the perception/action model [PAM]; Milner & Goodale, 1995), or more gradually as the action unfolds (i.e., the planning/control model [PCM]; Glover & Dixon, 2002). Moreover, closed-loop (CL) and open-loop (OL) trials were examined to determine whether online visual input influences resolution of the illusion-evoking elements of a pictorial display. As such, participants ( $N = 18$ ) reached out and grasped small (5-cm) and large (7-cm) objects embedded within the fins-in and fins-out Müller-Lyer (ML) configurations in CL and OL visual conditions. Notably, for each grasping response, movement time (MT) was normalized and grip aperture (GA) was computed at 4 equally spaced time points: 20, 40, 60, and 80% of MT. Our results showed that GA for the fins-out ML configuration was reliably greater than the fins-in ML configuration during OL but not CL trials. These results suggest that when visual input is available during response execution, the online visuomotor system can readily annul the illusion-inducing elements of a pictorial display. When online visual input is not available during the response (i.e., the OL trials), it appears that offline visual processing is sensitive to the illusion-inducing elements of a pictorial illusion. The present findings are discussed in light of the theoretical tenets of the PAM and PCM.

### **Comparing the “Gender Gap” in Throwing Between German and American Teenagers**

Robertson, M.A., T. Ehl\*, and S. Langendorfer. Bowling Green State University;  
\*Bad Vibel-Gronau, Germany

Research on the overarm throw for force has consistently documented skill differences between boys and girls in the U.S. as great as 2 to 3 standard deviations (Thomas & French, 1985). Some feel this “gender gap” is the result of cultural expectations. The present study examined the cultural expectation hypothesis by comparing the throwing skills of 13-year-olds in Germany to the throwing skills of American 13-year-olds. Based on different sports preferences in the two countries, it was hypothesized that German children would

show developmentally lower ball velocities and throwing patterns than those of American children. A second hypothesis was that any gender differences would be much smaller in Germany than in the U.S. since throwing skills are not valued for German boys. To test these hypotheses, a study of American 13-year-olds by Pulito Runion, Robertson, and Langendorfer (2003) was replicated in Germany. German teens ( $n = 52$ ) performed 10 trials of the overhand throw for force while being videotaped from side and rear views at 60 Hz. Ball velocities were recorded with a radar gun. While the German ball velocities were significantly slower than the American velocities,  $p < .05$ , there was no Gender  $\times$  Country interaction,  $p > .05$ . In both countries, boys threw 23 ft/s faster than girls. Statistically significant developmental differences between Germans and Americans occurred for the boys' trunk, step, and forearm actions,  $p < .01$ , and for the girls' backswing and forearm actions. These results suggested that culture does impact overall performance patterns of the overhand throw, but not the performance differences found between boys and girls.

### **Preview Time and Visual Illusions**

Robertson, C., and M. Heath. Indiana University

A number of studies (e.g., Elliott & Lee, 1995; Gentilucci et al., 1996) have shown that pointing movements are not entirely refractory to the context-dependent nature of pictorial illusions. It has been suggested that the duration of target presentation might affect the sensitivity of pointing movements to illusory arrays (Westwood et al., 2002). To test that proposal, the present study sought to determine whether the temporal determinants of visual preview might impact the extent to which the motor system can be "tricked" by the illusion-evoking elements of a pictorial display. Specifically, transverse pointing movements directed toward the vertex of small (6.5 cm) and large (9 cm) fins-in and fins-out Müller-Lyer (ML) configurations were examined following 25, 50, 75, and 100 ms of visual preview. The onset of each pointing response was cued by the appearance of the ML figure; hence real-time visual input from the stimulus array was available at the time of response planning. Consistent with the well-documented perceptual effects of the ML illusion, movement times for the fins-out ML configuration were reliably greater than for the fins-in ML configuration for all but the 25-ms visual preview condition. Similarly, in all but the 25-ms visual preview condition, participants reliably overshot the fins-out ML configuration and undershot the fins-in ML configuration. These results suggest that the duration of stimulus presentation can influence the sensitivity of a pointing response to the context-dependent effects of a pictorial display. More specifically, and as a working hypothesis, we propose that visual preview times greater than 25 ms facilitate top-down information processing, thus heightening putative interactions between allocentric and egocentric visual frames of reference.

### **Auditory Motor Processing in Typically Developing Children: A Cross-Sectional Study**

Roche, R., C. Horn, T-Y. Chang, P. Viswanathan, and J. Whitall. University of Maryland at Baltimore

Auditory-motor processing (AMP) is an example of the integration between sensory information and motor performance. There is limited literature on AMP in children, and no information about when children learn to adapt AMP in response to changed auditory information. The purpose of this study was to observe how well typically developing children could adapt to the coupling between auditory signals and finger taps under gradual and abrupt changes in sensory cues. Participants were 26 children: Group 1 ( $n = 8$ , ages 4–6 yrs,  $M = 5.25 \pm 0.89$ ); Group 2 ( $n = 9$ , ages 7–8 yrs,  $M = 7.56 \pm 0.53$ ); Group 3 ( $n = 9$ , ages 10 yrs,  $M = 9.44 \pm 0.53$ ). Movement difficulties were ruled out using the Movement Assess-

ment Battery for Children. Prior to the experiment, auditory perceptual threshold was established using a psycho-physical staircase method. Participants then tapped their index fingers alternately, in time with two auditory signals presented via headphones for 25 sec. The session consisted of 2 blocks of 12 trials. In both blocks, the first 2 and the last 2 trials had auditory signals with alternate beats that were 180° out of phase (baseline) with each other. In the abrupt condition the middle 8 trials had auditory signals that were 200° or 225° out of phase, depending on the perceptual threshold. In the gradual adaptation block, the middle 8 trials had 2 trials each that were 185, 190, 195, and 200° out of phase with each other. The gradual and abrupt adaptation sets were given in random order and were separated by a 5-min break. Movement was captured at 100 Hz using a motion monitor magnetic tracking system. As age increased, the perceptual threshold decreased. Group 1 = 32° ± 10.84; Group 2 = 29.44° ± 9.5; Group 3 = 26.67° ± 10.6). Qualitative and statistical analyses indicate that Group 1 was not able to modulate fingers taps in either block. Groups 2 and 3 were able to modulate in the abrupt block, and only at 200° out of phase in the gradual block. Group 3 appeared more adult-like. We conclude that, in the task of bilateral finger tapping, children are not able to adapt to a change in auditory phasing information even though they can cognitively perceive that change, until at least 7–8 years of age. In contrast to previous work with adult tapping, it would appear that younger children do not subconsciously adapt to changed auditory information.

**Home Affordances and Motor Development in Young Children: Validation of the AHMD-SR (Affordances in the Home Environment for Motor Development–Self-Report)**

Rodrigues, L.<sup>1</sup>, and C. Gabbard<sup>2</sup>. <sup>1</sup>Viana do Castelo Polytechnic, Portugal; <sup>2</sup>Texas A&M University

For the past 40 years, effort has been devoted to mapping the relationship between the home environment and selected aspects of the child's development. Although motor items have been included in noted inventories such as the HOME (Caldwell & Bradley, 1984), the fact remains that minimal information is available in relation to the multidimensional effects of the home on motor development. In addition, we still lack a valid measure reflecting aspects of the home environment that influence early motor development (e.g., Abbot et al., 2000). To fill this void, we have been conducting a line of research devoted to the creation of an innovative self-reporting research instrument that assesses the quality and quantity of motor development affordances in the home for children ages 3 to 42 months: the AHMD-SR. Initial development of the inventory, validation of its latent factorial structure, and testing of its internal consistency resulted in an age-related instrument with a 5-factor structure (Outside space, Inside space, Variety of stimulation, Gross motor toys, and Fine motor toys) that proved capable of discriminating among motor affordances in the home, as reported previously. The research presented here extends the ongoing study by reporting the validity and robustness of the construct, that is, the relationship between home items and level of motor behavior. Fifty young children between 24 to 36 months of age had their motor development and their home assessed using the PDMS-2 and the AHMD-SR. The outcomes were then used for examining the hypothesized relationship between motor assessment and results from the self-report inventory. Overall, our results indicate that there is an optimal range of the number and variety of affordances that influence level of motor development of the children studied.

### **Eliminating Gender Differences: The Influence of Endpoint Accuracy Constraints on a Fitts' Tapping Task**

Rohr, L.E. and F. Allard. University of Waterloo

The purpose behind these two studies was to contrast the performance of men and women when completing a reciprocal tapping task while varying the movement endpoint constraints. Although women are typically faster when completing fine motor activities (Kimura, 2000), these results arise from tasks wherein movement endpoint (accuracy) is highly constrained (Chipman, Hampson, & Kimura, 2002; Nicholson & Kimura, 1996; Schmidt, Oliveria, Tocha, & Abreu-Villaca, 2000). To further examine gender differences in a fundamental movement task, we had 131 right-handed participants complete a classic Fitts' reciprocal tapping task at four indices of difficulty (ID): 3.5, 5, 6.5, and 7.9 bits. A main effect of ID value was apparent, but no gender differences between genders was revealed (women = 428 msec, men = 409 msec). However, further analysis showed that for the more difficult tasks (6.5 and 7.9 bits), men moved significantly faster than women. One explanation accounting for these differential results is based on the strategies adopted by both sexes when completing a simple movement task: men may sacrifice movement accuracy while emphasizing speed, whereas women may be more concerned with reducing overall movement errors. To explore this concept, we conducted a second reciprocal tapping study (ID values ranging from 1.12 to 7.3 bits) wherein endpoint accuracy was constrained via metal targets and an electronic counter. Here, where no flexibility was permitted at movement endpoint, no gender differences were found across any of the six ID values. It appears therefore that when overall movement accuracy requirements are fixed and participants are restricted with regard to the endpoint of the movement, men and women perform without differentiation, challenging Kimura's (2000) view that women have an advantage for fine motor activities.

### **On the Sharing of Sensory and Motor Representations During Movement Production**

Rolheiser, T., G. Binsted, and K. Brownell. University of Saskatchewan

A major question remaining in the domain of spatial eye-hand coordination is whether sensory (eye) and motor systems share a common spatial representation of the workspace. In response, recent studies using a number of manipulations including saccadic adaptation (Bekkering et al., 1995), illusions (Binsted & Elliott; 1999; Binsted et al., 2001), and transcranial magnetic stimulation (TMS: Van Donkelaar, 1997) appear to demonstrate the rapid integration of two discrete representations during movement planning and execution. Interestingly, a significant literature has developed over the last 15 years depicting a 2-sec time-course for the decay or disruption of a functional motor map (e.g., Elliott & Madelena 1987, cf. Heath & Westwood 2003). Conversely, in a recent examination (Rolheiser & Binsted 2003) we demonstrated that the saccadic system utilizes a temporally transient world account, impairing the precise generation of eye movements immediately upon the removal of vision. This disparity becomes more paradoxical given the apparent integration of the maps during coordinated eye-hand movements. The purpose of this study was to isolate the influences of motor and sensory maps within the production of reciprocal pointing movements (i.e., Fitts' tapping). Participants were instructed to point as rapidly and accurately as possible between two target locations for 10 seconds. Following an initial 5-sec movement interval, vision of the targets was removed and eye movements were restricted throughout. This manipulation permitted a pseudo-continuous account of the psychometric function attributable to the manual motor representation in the absence of eye-hand map-integration.

Contrary to predictions of a shared spatial resource hypothesis, the memory stores for each effector (eye, hand) appear unique, at least when being accessed in isolation. Results are discussed with regard to current models of eye-hand coordination as well as the implications for streams of perception-action (e.g., Glover 2003).

### **Impaired Adaptation to Increasing Balance Threats: A Comparison of Children With Cerebral Palsy and Typically Developing Children**

Roncesvalles, M.N.<sup>1</sup>, M. Woollacott<sup>2</sup>, and P. Burtner<sup>3</sup>. <sup>1</sup>Texas Tech University; <sup>2</sup>University of Oregon; <sup>3</sup>University of New Mexico

What underlies the postural problems exhibited by children with cerebral palsy (CP)? Mechanisms underlying impairments in balance control were explored by comparing 8 children with CP to typically developing children (age-matched,  $n = 25$ ; and developmentally-matched,  $n = 15$ ). Increasingly larger and faster perturbations (indexed as easy-moderate-difficult) were imposed via a moving support surface (hydraulic platform); electromyograms (surface EMG) of the gastrocnemius, and tibialis anterior were recorded simultaneously. Integrated EMGs (IEMG) were calculated (70–300 ms postperturbation) and normalized to baseline levels. For each child the linear trend of IEMG magnitude relative to increasingly difficult conditions was defined as the adaptability index. Problems in balance control were hypothesized to be due either to: (a) reduced ability of agonist muscles to contract relative to the magnitude of balance threats; (b) delay in muscle contraction; or (c) simultaneous contraction of antagonist muscles, reducing the efficiency of the agonist burst. Typically developing children increased their muscle responses (IEMG) commensurate to larger/faster perturbations, while children with CP did not. No differences were found between groups in muscle onset latency, nor antagonist co-contraction. Instead, significant differences were found in the ability to increase muscular contraction (adaptability index) with increasing threats, in favor of the group of typically developing children. This study has shown that a primary constraint on balance recovery in children with CP is the insufficient level of contraction of agonist postural muscles when confronted with larger and faster perturbations.

### **Bimanual Coordination of an Asymmetric Aiming Task in Humans with Stroke Related Brain Damage**

Rose, D., and C. Winstein. University of Southern California

Interlimb temporal and spatial coupling are central features of human motor control. Unilateral brain damage from stroke can be considered a perturbation to the CNS, and therefore provides a unique model for studying the neural control of bimanual movements. We hypothesized that evidence of interlimb coupling would persist, albeit attenuated, as evident by the degree to which one limb's performance could be predicted by the contralateral limb in an asymmetric bimanual task. Thirty adults poststroke (ST) (18 M; mean age  $63 \pm 12$  yrs; 18 w/left hemisphere lesion) and 30 adults w/o stroke (C) (19 F; mean age  $67 \pm 11$  yrs) performed 20-trial blocks of a ballistic bimanual lateral aiming movement. A 10-, 15-, or 20-cm height-barrier (B) was placed midway in the path of the paretic (P) or nonparetic (NP) limb with the path of the contralateral limb barrier-free (NB). The C group performed the task with the left (L) arm analogous to the P arm of the ST group. Movement time (MT) was determined from photo-emitting diode switches at the home and target positions. Maximum vertical displacement (VD) was captured via electromagnetic sensors attached to each hand. Regression analyses were used to quantify interlimb coupling. NB limb MT and VD were regressed separately on B limb MT and VD to determine the % variance ( $R^2$ ) in performance of NB limb explained by that of the B limb. A two-factor Group (ST, C)  $\times$  Limb (P or L, NP or R) ANOVA using coupling  $R^2$  revealed an attenuation of coupling after stroke for both MT (C =  $.93 \pm .15$ ; ST =  $.82 \pm .27$ ) and VD (C =  $.87 \pm .21$ ; ST =  $.75 \pm .36$ );  $p$

< 0.05. Although smaller than controls, the 75–82% variance in one limb explained by the contralateral limb for the stroke group suggests a potential benefit from bimanual task protocols for rehabilitation.

### **How Persistent is the Contextual Interference Effect?**

Russell, D.M.<sup>1</sup>, and K.M. Newell<sup>2</sup>. <sup>1</sup>Penn State Berks–Lehigh Valley College; <sup>2</sup>The Pennsylvania State University

The contextual interference (CI) effect holds that practicing under a random schedule diminishes performance during acquisition, but enhances retention and transfer test performance. These findings have been interpreted as random practice having a temporary negative influence on performance but persistent beneficial effects on motor learning. However, usually only a few trials are employed during retention and transfer tests, hence the persistence of the CI effect has not been adequately assessed and we cannot make firm conclusions as to the benefits on learning. Furthermore, knowledge of results (KR) is typically removed in CI studies during the retention test, thus making it more like a transfer test. This study examined the persistence of the CI effect using a rapid sequential aiming task and provided KR during both practice and testing. Participants ( $N = 48$ ) practiced 3 movement patterns for 3 blocks of 18 trials under either a blocked or random schedule. A 24-hr delayed retention test also included 3 blocks of 18 trials. During retention, the random and blocked groups were further subdivided so that half of each group performed a random test while the other half performed a blocked test. After completing the retention test, all participants performed a new movement pattern as a transfer test. During practice, the blocked group performed significantly faster than the random group. In agreement with the CI effect, the random practice group outperformed the blocked practice group during the random retention test, and maintained this advantage throughout the 3 blocks of trials. However, in contradiction to the CI effect, the blocked group performed as accurately and quickly as the random group throughout the blocked retention test. And, during the transfer test significant differences were found on only the initial two trials. These results support a variant of the specificity-of-practice principle: random practice is essential for random test conditions, but it provides no advantage for blocked test conditions. In summary, the CI effect should be considered to arise from negative transfer, rather than positive transfer as usually promoted.

### **Nonisotropic Coupling and Manual Asymmetries in Bimanual Coordination: Interaction of Spatial and Temporal Variables**

Ryu, Y.U., and J.J. Buchanan. Texas A&M University

A circle-tracing task was used to study nonisotropic coupling and manual asymmetries in bimanual coordination. Seven right-handed participants traced target circles with their left (LH) and right hands (RH) in both symmetric and asymmetric modes of coordination. The target circles were 3 cm and 15 cm in diameter and two target sets were used: (1) a 3–15 set, LH traces a 3-cm circle and RH traces a 15-cm circle; and (2) a 15–3 set, LH traces a 15-cm circle and RH traces a 3-cm circle. Circle tracing was paced with an auditory metronome scaled from 1 to 3 Hz in .25-Hz steps. Two findings highlight the role of nonisotropic coupling in manual asymmetries: First, when tracing the 15–3 set, phase wrapping was the predominant form of behavior in all asymmetric trials and in 83% of the symmetric trials. Phase wrapping emerged as the result of significant slowing of the nondominant LH as pacing frequency increased, with many episodes of 2:3, 3:4, 3:5, and 4:5 frequency ratios between the hands (LH:RH). Second, when tracing the 3–15 set, 1:1 phase frequency locking occurred in 52% of the asymmetric trials and 93% of the symmetric trials. The predominance of phase wrapping in the 15–3 set demonstrates nonisotropic



coupling, with the dominant RH expressing a stronger coupling influence on the nondominant LH than vice versa. The phase wrapping observed in the 3–15 asymmetric condition with increasing cycling frequency demonstrates the sensitivity of the coupling to movement frequency, consistent with previous bimanual circle studies. The results reveal functional differences in dominant and nondominant arm coupling as a function of spatial and temporal variables. This suggests the degree of nonisotropic coupling emerges through interaction of hemispheric differences in arm control and task constraints during bimanual coordination.

### **Differential Menstrual Phases and Psychological Make-up in Tennis Players**

Saha, S., S. Chakrabarti, and P.K. Chattopadhyay\*. Bangladesh Institute of Sports;

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Ten adolescent female tennis players from the premier sports training institute in Bangladesh (mean age = 14.8;  $SD = 1.4$ ) were assessed for reaction ability (reaction and movement time), anticipation, cortical arousal (two-flash threshold), and autonomic activity as measures of emotional control (bilaterally recorded skin conductance spontaneous fluctuation and autonomic adaptation level). These assessments were done throughout the years 2002–03 in 4 phases: Day A, onset of menstruation; Day B, end of menstruation for that cycle; Day C, predicted day of ovulation; and Day D, late luteal phase. Results indicated that heightened level of cortical activation had a positive impact on reaction ability, both in reaction and movement time, during the luteal phases of the menstrual cycle. Furthermore, symmetry in bilateral autonomic regulation appeared consistent in luteal phases, whereas though consistent, data obtained during the proliferative phases were characterized mostly by asymmetry in autonomic activity. Again, heightened ability to modulate autonomic arousal especially during the late luteal phase was found to facilitate reaction performance, particularly with respect to faster movements. An attempt was made to relate the differential phases of menstruation and psychological parameters in relation to sport performance.

### **Effect of Seasonal Changes on Menstrual Cycle and Sports Performance—An Exploratory Study**

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The purpose of this study was to generate awareness among top-level adolescent female tennis players in Bangladesh, and their coaches, with regard to possible changes that may occur in certain psychological parameters during differential phases (prolif and luteal) in the menstrual cycle. Ten tennis players selected for the experiment were assessed for reaction ability (reaction and movement time), anticipation, level of cortical arousal, and autonomic activity as a measure of emotional control (bilaterally recorded skin-conductance spontaneous fluctuation and autonomic adaptation level), in different seasons throughout the year 2002–03. Each was assessed for these parameters four times per menstrual cycle: Day A, onset of menstruation; Day B, end of menstruation for that cycle; Day C, predicted day of ovulation; and Day D, late luteal phase. Results showed that each participant had her best reaction and movement time during the postovulation luteal phase, and the late luteal phase during sprint. Furthermore, each could anticipate most accurately in all the menstrual cycle phases during the spring season. Contrary to that, in the late luteal phase during late summer, all participants were observed to have the highest level of cortical activation. Again, during spring, all phases (A, B, C, and D), bilateral symmetry in autonomic activity was observed in all participants, which has already been suggested as a facilitator in producing high levels of emotional control and, thereby, high sport performance. Changes in psychological menstruation are discussed.

### **Qualitative Study in the Forming Process of Sport Commitment for Exceptional Youth Soccer Players**

Saito, S., K. Kitamura, and T. Nagayama. Sendai City, Japan

The purpose of this study was to clarify the forming process of sport commitment that exceptional youth soccer players were showing. Sport commitment is defined here as a psychological state that is being formed by the investment of personal effort and resulting in the individual realization of meaning in playing sport. Twenty players and their parents and coaches participated in this research. Semi-structured interviews were conducted which focused on the process of forming sport commitment during the period from the players' early childhood to high school age. The interview data were transcribed verbatim and then analyzed using qualitative data analysis (Côté, 1993). As a result, two categories emerged: enjoyment of playing soccer (self-efficacy, flow and cause of playing soccer) and creating the most suitable environment for the players (continued practices for training themselves and the sense of acceptance by significant others). Greater enjoyment in playing soccer and creating the most suitable environment led to higher levels of sport commitment. This suggests that the interaction of these two factors gradually shapes sport commitment.

### **Interactive Effects of Perceptual and Motor Constraints on Hand-Foot Coordination Dynamics**

Sallesse, R., and J.J. Temprado. Université de la Méditerranée

The present study addressed the issue of the contribution of perceptual and/or motor factors to hand-foot coordination. Participants performed cyclical flexion-extension movements of the right hand and foot under two conditions of directional coupling, isodirectional or nonisodirectional. Depending on the position of the forearm (prone or supine), the coordination patterns were performed with similar or dissimilar muscular coupling with respect to phylogenetic origin as antigravity muscles. Thus four coordination patterns were performed, resulting from crossing directional and muscular constraints. The task was performed either with full vision or no vision of the limbs. We analyzed the number of phase transitions as well as mean relative phase and relative phase variability. Results showed that visual perception of the limbs enhanced or reduced the stability of coordination depending on the direction of limb movements (i.e., same or opposite directions). Moreover, the effects of visual information were subordinated to muscular coupling. These findings suggest that hand-foot coordination stability and phase transitions are governed by factors that result from a coalition of both perceptual and motor constraints.

### **Interactive Effects of Directional and Muscular Constraints on Bimanual Coordination Dynamics**

Sallesse, R., J.J. Temprado, and E. Laroque. Université de la Méditerranée

The present study addressed the issue of the contribution of directional and/or muscular constraints to bimanual coordination. Participants performed cyclical flexion-extension movements of the wrist in the sagittal plane, thereby leading to up and down movements of the hand side-to-side of the middle axis of the body. Four coordination patterns were performed, resulting in crossing relative direction of the displacement of moving limbs, isodirectional or nonisodirectional, and muscular coupling, the simultaneous activation of homologous and nonhomologous muscles. The task was performed either with full vision or no vision of the limbs. We analyzed the number of phase transitions as well as mean relative phase and relative phase variability. More transitions were observed in the nonhomologous coupling condition than in the homologous coupling condition. However, a striking result was that phase transitions were observed for nonisodirectional patterns,

even in the homologous coupling condition. Moreover, visual perception of the limbs enhanced the stability of coordination regardless of direction of limb movements and muscular coupling (i.e., same or opposite directions). These findings suggest that when the egocentric constraint is suppressed, bimanual coordination stability and phase transitions are governed by factors that result from a coalition of both directional and muscular constraints.

### **Visual Search Strategies of Ski Racers Under Laboratory Conditions**

Saso, H., T. Kato, T. Fukuda, and T. Kitao\*. Fujisawa-shi, Japan; Kyoto-shi, Japan

The purpose of this study was to examine differences in visual search strategies between expert and novice Alpine ski racers during sequential phases between gate to gate under laboratory conditions. In particular we focused on how they utilize peripheral vision properties to pick up visual information. College Alpine ski racers (expert group) and ordinary college students who had never experienced Alpine ski racing (novice group) participated in this experiment. They sat in front of the screen, viewed skis with Giant Slalom set by the simulation film, and their eye movements were measured. Eye movements during the cut-over phase of skiing, in which a skier should gather visual information from the course, were analyzed. The results showed that the distribution of experts' viewing points was more focused around the gate than was that of novices. Furthermore, experts were analyzing the motion ahead of time by utilizing peripheral vision to pick up important course information for skiing, whereas the viewing point of novices was limited to small areas around them. A possible interpretation of these results is that experts are cognizant of the line they will ski with, utilizing peripheral vision from the entire course, while novices are not capable of analyzing the motion ahead of time.

### **Dynamic Testing**

Schack, T. German Sportuniversity Cologne

This article examines test procedures that go beyond traditional status diagnosis by focusing on activating and assessing a person's learning and action potential. It is proposed that dynamic testing is an appropriate diagnostic strategy for assessing this potential for change and for identifying the relevant variables experimentally. It is introduced within a framework of current approaches to intelligence testing and the testing of motor abilities and skills. Special experiments and tests show how the various approaches to testing integrate feedback and prompts into their procedures in order to elicit a learning process and estimate learning potential. The paper focuses on such applied fields as top-level competitive sports, sensorimotor performance domains in the field of aviation, and curriculum-oriented procedures for children with motor impairments. Finally, the potentials and drawbacks of the approach are discussed along with consequences for a research perspective that places more emphasis on change.

### **Mental Representation and Performance in Golf**

Schack, T.<sup>1</sup>, and L. Pollers<sup>2</sup>. <sup>1</sup>German Sportuniversity Cologne; <sup>2</sup>University of Leuven

The aim of the paper is to question to what extent there are connections between performance and mental representations in different techniques in golf. For experimental studies on this topic, we chose a special method to measure the structure of mental representations in motor memory (Schack, 2002). By using an expert-beginner paradigm, we found differences in the structure and organization of mental representation between experts and beginners. In contrast to beginners, the mental structure of persons with a high ability to perform is more differentiated and more strongly function-oriented. By means of

an invariance measure of the SDA-M-method, we found a significant difference between mental structures of experts ( $n = 30$ ) and novices ( $n = 30$ ) in golf,  $p < .01$ . The consequences for a new kind of mental training based on mental representation will be discussed.

### **The Effect of Asymmetric Starting Position on Temporal and Spatial Measures in a Bimanual Pointing Task**

Schmidt, M., and A. Mason. University of Wisconsin

In this study we examined the coordination of limbs in a bimanual pointing experiment. Many studies have tested the effect of end-point task characteristics (target size, object shape, task, etc.) on between-limb coordination to determine variables that cause the limbs to operate synchronously or independently. A common feature of these experiments is that the initial position of the limbs is bilaterally symmetrical. In the experiment presented here, we utilize a pointing task in which the initial positions of the hands are not symmetrical, and we utilize both temporal and spatial measures to evaluate control of the limbs. Seated participants ( $N = 9$ ) performed a bimanual pointing task with their index fingers to 1.9-cm diameter targets placed on a horizontal surface in front of them. Four types of trials were performed as defined by the symmetry of initial hand placement and the congruence of reaching distances. Initial hand placement was either symmetrical or asymmetrical, corresponding to 0 or a 10-cm difference in the anterior-posterior direction. Bimanual reaching distances were either congruent (both hands moving 20 or 30 cm from the initial position) or incongruent (one hand moving 20 cm, the other 30 cm from the initial positions). Kinematic data were obtained for the index finger, first knuckle, and wrist of both hands using a VisualEyz (Phoenix Technologies) 3-D motion capture system operating at 200 Hz. The results indicate that an asymmetrical initial hand position affects the temporal synchrony of the limbs at movement initiation depending on the congruence of distance to target. In addition, the more extended initial position resulted in lower peak and mean velocity regardless of distance to target, hypothesized to be an effect of limb mechanics. In addition, distinct participant-specific strategies for the spatial control of the limbs were demonstrated. These results will be discussed in terms of functional coupling/decoupling of the limbs resulting from task demands.

### **Effect of Movement Speed on the Joint Coordination Underlying a 3D Reaching Task**

Scholz, J., T. Dwight, J. Lynch, and Y-w. Tseng. University of Delaware

Redundant joint combinations available to the CNS to control reaching are coordinated so that joint combinations that deviate the instantaneous hand position from the planned hand path are resisted while joint combinations that are consistent with a stable instantaneous hand position are less resisted, depending on other task constraints. We argued previously that muscular control itself tends to perturb the evolving movement because of resulting interaction torque. Thus, reducing unnecessary control (i.e., leaving joint combinations unrestricted when they do not affect the hand's instantaneous position) provides advantages by eliminating unnecessary perturbations due to interaction torque. This study sought to determine whether there is evidence for an enhanced use of this control strategy when reaching at higher speeds, resulting in increased interaction torque. Six right-handed participants reached to different targets with their left arm at movement times (MT) of 400, 800, and 1200 ms. MT feedback was provided after each trial. Trials deviating by more than 50 ms from the required MT were eliminated. Motor redundancy was addressed using the uncontrolled manifold (UCM) approach to partition joint variance into variance consistent with hand path stability (GEV) and variance leading to a change in the hand path (NGEV). More GEV is expected if joint combinations that do not affect the hand path are not resisted.

However, our hypothesis about speed effects was not supported. More goal-equivalent joint combinations (GEV) were actually observed when reaching at the slower speeds. However, NGEV also decreased with increasing speed, leading to less variability of the instantaneous hand position from trial to trial at fast speeds. On the other hand, the normalized difference between GEV and NGEV was greatest for the faster speeds. The relevance of the frequently observed UCM effects for control will be discussed in light of these results.

### **Effects of Focus of Attention Depend on Skill and Availability of Knowledge of Results**

Schorer, J., and R. Wollny. Heidelberg, Germany

Recently Perkins-Ceccato, Passmore, and Lee (2003) showed in a golf pitch task that skill influences the effects of focus of attention (FA). Their results support an external FA for experts and an internal focus of attention for novices. In contrast, the data from an experiment by Ehrlenspiel (2001) on basketball free-throws with experts showed only little superiority for an external FA in comparison to internal FA, but there was a significant difference in process-related EMG data. These results are in line with the hypothesis that rigid control of degrees of freedom is released with increasing expertise (cf. Bernstein, 1967; Vereijken, van Emmerick, Whiting, & Newell, 1992), but the difference in the effect of external FA remains. It may result from differences in availability of knowledge of results (KR). Perkins-Ceccato et al. occluded vision to eliminate the effect of KR, whereas Ehrlenspiel allowed KR. To test the hypothesis of an additional effect of KR and FA in dependency of skill, we examined in this study the influence of two internal and one external set of FA instructions in interaction with availability of KR and skill of dart players (experts vs. novices). Six dart players in each skill group were asked to throw darts on the bull's-eye. The six conditions were counterbalanced in groups across players. Under internal focus Condition 1, the participants were asked to concentrate on the return point of the movement, whereas in internal Condition 2 they had to focus on the release point. For external FA they were told to concentrate on the target. Feedback was varied by occlusion goggles, either opened (KR) or closed (NO-KR) by an experimenter. Dependent variables were three different measures describing throwing results (root-mean-square error, centroids, bivariate variable error) and (b) two measures describing throwing execution (kinematics of the right arm and EMG data of three movement related muscles). Preliminary results support the hypothesis of an additional interaction effect of availability of KR.

### **Controllability of Visual Motor Imagery Over the Lifespan**

Schott, N. University of Giessen

Based on the effects of mental practice, several researchers have proposed its use in orthopaedic and neurological rehabilitation such as after stroke or in Huntington disease, as it may be a novel and cost-efficient tool (Jackson et al., 2001; Page et al., 2001). However, clinical research data supporting the proposal is not yet available. Yaguez et al. (1999) stress the importance of assessing the motor imagery ability of patients before considering its use as a therapeutic tool. After individuals are instructed to imagine a certain movement, there is no way to control whether they are doing so. The present study involved older adults (74 M, 72 F) ranging in age from 21 to 85 years who completed a test of the controllability of visual motor imagery. Two conditions were completed, a recognition test and a regeneration test. In both conditions the participants had to perform 6 following instructions. They were asked to imagine their body posture while blindfolded. They could move only one body part per instruction. In the regeneration test they had to execute a movement to the final position. In the recognition test, they had to select among 5 pictures the one that fit their imagery. Each item was scored when correct. A  $3 \times 7$  (Condition  $\times$  Age group)

mixed-design ANOVA revealed a significant main effect for condition with lower percentages for the regeneration test than the recognition test,  $F(2, 150) = 180.3, p < .001, \eta^2 = .516$ , and a significant interaction for Condition  $\times$  Age group,  $F(8, 282) = 2.05, p = .041, \eta^2 = .055$ . The between-subject effect for group was significant,  $F(4, 141) = 27.92, p < .001, \eta^2 = .461$ . For both tests, adults 60 years and older exhibited significant differences for the percentage distribution compared to younger adults. The older adults produced more errors than younger adults. There were no gender differences in either test. Our results demonstrate that especially the younger age groups performed the imagined movements in an equivalent manner for both conditions. For adults 60 years and older, the usefulness of mental practice for neurological and orthopaedic rehabilitation seems limited. The results suggest that the ability to visualize the performing scene vividly and accurately is a key factor in increasing the efficacy of mental practice.

### **Effects of Beverage Flavor on Athletic Performance, Mood, and Workload**

Schuler, A., A. Rawson, and B. Raudenbush. Wheeling Jesuit University

Previous research indicates that the administration of peppermint odor can augment athletic performance and mood, and decrease workload demands. The present study extended those findings by evaluating athletic performance and physiological changes during the administration of flavored beverages. Utilizing a within-subjects design, athletes performed a 15-min modified treadmill stress test. At 3-min intervals they consumed 50 ml of beverage (peppermint water, unadulterated water, or Gatorade sports drink). In the control condition no beverage was consumed. Pre- and posttesting physiological measurements were taken (blood pressure, pulse, oxygen concentration). In addition, ratings of mood (via the Profile of Mood States) and workload (via the NASA Task Load Index) were completed. No physiological changes were noted. However, both the peppermint and Gatorade sports drink conditions led to greater ratings of personal performance and increased mood. These results provide additional support for the implementation of nonpharmacological methods to increase an athlete's performance and mood during exercise or competition.

*Funded by a grant from NASA*

### **Influence of Rule Complexity on Implicit and Explicit Learning of a Tracking Task**

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Previous studies have reported an advantage (Green & Flowers, 1991), disadvantage (Willingham et al., 1989), and no advantage (Sekiya, 1998) of implicit learning over explicit learning. This study hypothesized that complexity of rules influences the efficacy of implicit and explicit learning. Participants (24 M, 24 F) manipulated a handle to pursuit-track a target cursor that moved in waveforms toward the bottom of a monitor and abruptly speeded up in the last segment. Target pathways in the last segment (6th) were decided by movements in the preceding segment (5th) for the simple rule groups, and by a combination of the preceding two segments (4th and 5th) for the complex rule groups. Each participant learned two rules that were applied to 60% of all trials, whereas 40% had random pathways. There were four groups: implicit-simple, implicit-complex, explicit-simple, and explicit-complex. A total of 144 acquisition trials and 12 immediate-retention trials were performed on the first day. Twelve delayed-retention trials and a questionnaire were completed on the next day. Responses to the questionnaire showed that implicit-learning participants had no awareness about the rules. ANOVAs showed that tracking performance was better for trials with the rules than for randomized trials,  $p < .05$ , in acquisition and retention, regardless of awareness of the rules. However, explicit learning led to better tracking performance than

implicit learning,  $p < .05$ . The complexity of rules did not influence these findings, suggesting that efficacy of implicit and explicit learning were not influenced by the two levels of complexity used in this study.

### **Long-Term Effects of Iron Deficiency on Motor Development**

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Approximately 20–25% of all infants in the world have iron deficiency anemia (IDA), and many more have iron deficiency without anemia. It has been shown that infants suffering from IDA score lower on motor development tests than infants with adequate iron levels. The purpose of this study was to determine the long-term effects of iron deficiency in infancy on motor development. This longitudinal study followed 185 full-term healthy infants from Costa Rica who entered the study at age 12–23 months and varied in iron status from moderate IDA to iron sufficiency. Their motor development was assessed using the Bayley Scales of Infant Development (PDI) before and both 1 week and 3 months after iron treatment. The children's motor development was assessed again at the age of 5 years using the Bruininks-Oseresky Test of Motor Proficiency, and at the age of 11–14 years using the short form of that test. The Bruininks-Oseresky scores were re-scaled to match those of the Bayley scale. A propensity score, used to simulate a randomized controlled trial in observational studies, controlled for initial group differences in background characteristics such as gender, birth weight, mother IQ, etc. This longitudinal analysis (SAS Proc Mixed) compared children with good iron before and/or after treatment in infancy with those who had had chronic severe iron deficiency, with or without anemia. Children who had chronic, severe iron deficiency in infancy not only scored lower in motor tests during infancy, but also continued to score lower with the same magnitude of difference at age 5 years and during adolescence. In both groups, boys scored higher than girls in adolescence, but no gender differences were detected at earlier ages. The study shows that children with chronic severe iron deficiency in infancy show poorer motor development through early adolescence, with no catch-up despite iron therapy.

### **Proportional and Nonproportional Transfer of Movement Sequences**

Shea, C., and H. Wilde. Texas A&M University

Recent sequence-learning experiments have determined a great deal about how movement sequences are processed, stored, and executed, but very little is known about the transfer of sequence knowledge to changed movement demands. However, a number of theoretical proposals argue that sequence knowledge is independent of the specific articulatory activities that produce the movement sequence (Keele et al., 1995; Verwey, 2001; also see Schmidt, 1975). In Experiment 1 participants practiced one of two 16-element arm extension/flexion sequences, long or mixed. The two sequences were identical in terms of sequence order but different in terms of spatial location of one of the targets. The long sequence used targets located at 20, 40, 60, and 80° from the start position. The mixed sequence involved targets located at 20, 26.67, 40, and 60° from the start position. Three test sequences (long, short, and mixed) were conducted approximately 24 hrs after completion of the acquisition session. The long and mixed sequences were identical to those used for the different groups during acquisition. The third test was called the short test and involved targets located at 20, 26.67, 33.33, and 40° from the start position. Thus the long practice group, for example, was administered a retention test (long test), a proportional transfer test (short test), and a nonproportional test (mixed test). Consistent with our predictions, the participants, regardless of practice sequence, could effectively apply the sequence

knowledge to the changed spatial locations. Interestingly, however, in Experiment 2, which provided extended practice on the long sequence, the participants were only able to effectively transfer to the proportional transfer sequence. Thus it appears that sequence knowledge becomes functionally integrated with movement specification commands after extended practice, allowing the movement to be rescaled but not restructured. The result of extended practice was loss of independence of sequence knowledge and decreased response flexibility.

### **To Average or Not to Average: Analysis of Surface EMG and the Control of Rapid Limb Movements**

Sherwood, D., and B. Enebo. University of Colorado, Boulder

The control of human limb movement has been the focus of considerable research for more than a century. A major issue to emerge from this work is the manner in which the central nervous system (CNS) organizes the central command to activate muscles to produce movements that differ in distance, velocity, or movement time (MT). The *impulse-timing model* suggests that the central command controls the intensity of muscular contraction and the time over which it is applied. The *pulse-step models* suggest that the duration of the agonist EMG is constant across changes in speed and distance. However, some studies have shown that EMG duration is constant for certain ranges of movement distances. In many studies, the EMG parameters were measured in a relatively insensitive analysis based on averaged data. By averaging over trials, the slight variations in timing seen from trial to trial would be lost in the averaging process. By carefully undertaking a trial-by-trial analysis, the principles of control could be redefined for the entire range of amplitudes. The task for the participants ( $N = 6$ ) was to move a lightweight horizontal aluminum lever to spatial targets located 5, 10, 15, 20, 30, and 50° from the starting location in three movement times determined for each condition: slow, medium, and fast. Potentiometer and surface biceps and triceps EMG data were sampled at 1,000 Hz. EMG duration was determined from the averaged records for each participant and condition, and from an individual trial analysis. Repeated-measures ANOVAs showed that averaging across trials underestimated initial agonist burst EMG amplitude at all movement distances and movement speeds compared to a trial-by-trial analysis. Only the largest movement amplitude showed a significant increase in EMG duration. The slowest movement speed had a significantly longer duration compared to either the fastest or intermediate movement speeds. Neither the pulse-step nor impulse-timing model could account for all the findings, suggesting the need for a hybrid model for the control of fast and accurate upper limb movements.

### **Does Walking With Electrical Stimulation of Ankle Musculature Improve Gait Lower Limb Joint Coordination of Children With Cerebral Palsy?**

Shewokis, P.A.\*, S. Pierce, C. Stackhouse, B.T. Smith, and J.J. McCarthy. \*Drexel University; Shriners Hospitals for Children, Philadelphia

Children with cerebral palsy (CP) are often unable to produce appropriate muscle activation patterns for efficient ambulation and effective joint coordination. We assessed the training/carryover effects of percutaneous functional electrical stimulation (ES) applied to the ankle musculature of children with CP when walking without ES. Two children with CP had intramuscular electrodes implanted on the tibialis anterior and gastrocnemius muscles. Foot switches activated the stimulation at appropriate times in the gait cycle. Each child underwent an orientation to walking with ES and accommodation to ES with a physical therapist. Walking at home with ES was performed twice daily, 5 days a week for 4 weeks with 5–6 hours rest between practice sessions (Shadmehr & Brashers-Krug, 1997). Weeks 1 and 2 of practice were for two 20-min sessions; Weeks 3 and 4 were for two 30-min ses-



sions. Knee, ankle, and hip motion during ambulation were recorded with a seven-camera VICON motion analysis system at baseline, after 2 and 4 weeks of training, and after a 2-week washout period. Angle-angle plots (Winstein & Garfinkel, 1989) and phase plane portraits (Burgess-Limerick et al., 1993; Winstein & Garfinkel, 1989) were calculated and compared to those of age-matched children of typical development. After training with ES, the coordination and control of the ankle and knee joints changed to a more tightly coupled swing phase (i.e., reduced dorsiflexion of  $5^\circ$  and slower ankle angular velocity of  $100^\circ \text{ s}^{-1}$  than the 2-week findings). Our results showed variability in the children's gait coordination patterns. Enhanced variability is expected since children demonstrate changes in their movement patterns as a function of practice (Thomas et al., 2000). Discussion focuses on the implications of ES and training and the role of variability (Van Emmerik & van Wegen, 2002) in assessing gait function in children with CP.

### **Novel Gait Training Paradigm Using FES to Improve Coordination in Children With Hemiplegic Cerebral Palsy**

Shewokis, P.A.\*, S. Pierce, C. Stackhouse, B.T. Smith, M. Orlin\*, and J.J. McCarthy.  
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Children with cerebral palsy (CP) often exhibit compromised joint coordination that may place additional strain on joints, decrease movement efficiency, and limit mobility. We assessed whether the effects of functional electrical stimulation (FES) applied to the ankle musculature while walking can improve lower limb coordination of children with hemiplegic CP when walking without FES. In this pilot study, we developed a novel exercise-training paradigm using the principles of memory consolidation (Shadmehr & Brashers-Krug, 1997). Four children with hemiplegic CP were randomly assigned to an FES or Control group. For the FES condition, surface electrodes were placed on the tibialis anterior muscle and peroneal nerve to produce dorsiflexion, while the Control group was provided with a gait training program that incorporated verbal cues. The children practiced walking at home with FES twice daily, 5 days a week for 4 weeks with 5–6 hours rest between practice sessions (Shadmehr & Brashers-Krug, 1997). Weeks 1 and 2 of practice were for two 20-min sessions daily; Weeks 3 and 4 were for two 30-min sessions daily. Knee, ankle, and hip motion during ambulation were recorded with a seven-camera VICON motion analysis system. Angle-angle plots (Winstein & Garfinkel, 1989) and RMSE were calculated for baseline and after 2 and 4 weeks of practice and were compared to those of age-matched children with typical development. After training with FES, in comparison to baseline, improvements were noted primarily in the knee and ankle. An important finding was a steeper negative slope during preswing, denoting antiphase coordination with the out-of-phase movements of the knee and ankle. We posit that improvements in gait function may be attributable to the combined effects of FES (through the provision of sensory feedback and muscle activation) and memory consolidation principles. The findings are discussed in terms of theoretical and clinical implications for the development of rehabilitation gait training protocols.

### **Is Preference for Proxy Contact Linked to Less Self-Efficacy and Greater Proxy Dependence? The Dilemma of Relying on the Exercise Instructor**

Shields, C.A., and L.R. Brawley. University of Waterloo

There are a number of exercise situations in which people look to others (i.e., proxies) to help them manage their exercise participation. Bandura (1997) notes that people may choose to enlist the help of a proxy when they believe they have insufficient self-regulatory skills and may better achieve their desired goals by using a proxy-agent. However, a di-

lemma arises as reliance on the proxy continues. While help from a proxy can have a positive influence on behavioral adaptation, Bandura cautions that continuing proxy dependence reduces the opportunity to build skills for efficacious action. We examined this dilemma with a twofold purpose: (a) to determine whether there are differences in self-efficacy and reliance between those preferring a high vs. a low level of proxy-contact; and (b) to examine whether proxy-efficacy is related to reliance on the proxy agent. Sixty active community-based adults participating in fitness classes completed measures of proxy-efficacy, reliance on the class instructor (proxy), frequency of enlisting help from others, and self-regulatory and task-efficacy. Efficacy was assessed with reference to two exercise contexts: structured class vs. sudden class elimination. A one-way (high/low contact) MANOVA revealed a significant main effect for preferred proxy-contact (Wilks' = .501,  $p < .001$ ). Participants preferring high proxy-contact reported significantly lower self-regulatory efficacy for both exercise contexts than their low contact counterparts. They also reported lower task-efficacy for exercising alone when deprived of the class ( $p$ 's  $< .004$ ). For the second purpose, we compared higher vs. lower proxy-efficacy individuals. The former reported a higher degree of reliance on the class instructor, and more often counted on others to help them manage their exercise participation (MANOVA Wilks' = .563,  $p = .001$ ; post hoc  $p$ 's = .001). These results illustrate the dilemma of reliance on a proxy and support Bandura's theorizing regarding the relationship between high proxy-contact, proxy dependence, and reduced personal efficacy.

### **Presentation is Everything: Links Between Self-Presentational Success and Physical Activity Cognitions, Affect, and Behavior**

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It has been suggested that successfully presenting oneself as an exerciser can have a motivating influence on physical activity (PA) participation (Leary, 1992). In accordance with self-efficacy theory (SET; cf. Bandura, 1997), experiencing self-presentational (SP) successes may play an important role in determining cognitive and affective responses to PA. Despite the suggested importance of successful self-presentation in the PA domain, little research has examined the social-cognitions underlying an individual's perception of SP success. Thus the purpose of the current study was twofold: (a) to examine whether those who differ in perceived success differ in cognitive, affective, and behavioral characteristics; and (b) to identify the social-cognitions important in prospectively determining whether individuals perceive themselves to be a SP success or failure. Active young adults ( $N = 452$ ; mean age = 21.80 yrs) recruited from a university fitness facility completed measures of SP efficacy, perceived success, causal attributions, affect, social-physique anxiety (SPA), and public self-consciousness (PSC). Attendance at the exercise facility was measured prospectively over an 8-week period, after which perceived success and causal attributions were measured again. Separate MANOVAs revealed a main effect for perceived success for both cognitive and affective variables (both  $p < .001$ ). Results indicated that individuals who perceived SP success reported higher SP efficacy, attributed their success to more internal, personally controllable, and stable causes, experienced greater positive affect, and reported lower SPA and PSC. An ANOVA revealed that those who had perceived themselves as successful in their SP had greater attendance over the next 8 weeks than those who perceived themselves as failures,  $p = .001$ . A prospective logistic regression revealed that SP efficacy, personal control, and stability were significant predictors of perceived success, correctly classifying 86% of participants,  $p < .001$ . The present findings support the integration of SP and SET in examining PA cognitions, affect, and behavior.

### **An EEG Psychophysiological Study on the Effects of Physical Activity on Preschool Children's Cognitive and Emotional Development**

Shih, H-H., J-H. Lin, C-T. Wu, C-L. Li, C-W. Chang, and T-M. Hung. Taipei, Taiwan

Preschool children are at a critical stage of cognitive and emotional development. The neural mechanism of how exercise can improve cognitive and emotional function in humans and animals has been widely studied and gradually become known to us in recent years. However, little is known about the effects of short-term physical exercise intervention programs on the cognitive and emotional development of preschool children. This study examined the effects of physical activity on preschool children's cognitive and emotional development via psychophysiological electroencephalographic (EEG). Preschool children ( $N = 120$ ) were recruited and first evaluated by the Basic Motor Ability Tests-Revised (BMAT-R); the score low-end of 32 children was evenly divided. The experimental group attended 9 weeks of a physical activity enhanced program. We recorded 3 minutes resting EEG of each child before and after the intervention at 6 electrode sites: F3, F4, Cz, Pz, O1, and O2. Cleaned EEG epochs of 2 seconds each were fast-Fourier transformed into 6 frequency bands:  $\delta$ (0.5–3.5 Hz),  $\theta$ (4–7 Hz),  $\alpha_1$ (7.5–9 Hz),  $\alpha_2$ (9.5–12.5 Hz),  $\beta_1$ (13–19 Hz), and  $\beta_2$ (20–30 Hz) and submitted to  $2 \times 6$  (Groups  $\times$  Site) ANOVA with repeated measures separately. The frontal asymmetry ratio calculated from L-R/L+R was also obtained and analyzed by  $t$ -test. Although the 9-week intervention programs only showed a trend but not statistically significant improvement over the cognitive and emotional development of these preschoolers, we found that function power in the slow-wave delta band was significantly negatively correlated with movement ability. In addition, regression analysis revealed that movement ability accounted for 48% of variance in preschool children's delta power. As an index of neural maturation, lower delta power indicates higher maturation of neural function. The negative correlation between movement ability and EEG delta power suggests that the preschool children with higher movement ability have developed a higher mature neural function. An intervention study of longer duration is suggested so as to further examine the causal relationship between physical activity and brain development in young children.

### **Perception of Kinetic Property With Action vs. Perception Alone**

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The theory of direct perception suggests that knowledge about dynamic object properties, such as lifted weight, is visually accessible to human observers. The purpose of the present study was to determine if such knowledge is universally available or whether it depends on observer variables (e.g., strength) and context variables (e.g., type of action involved). Observers may have access to perceptual-motor knowledge that provides more information than do merely cognitive tasks. Forty participants were classified into one of 3 strengths (weak, normal, and strong) and were randomly assigned to one of two groups. Group 1 estimated mass of a visually presented object by using pencil and paper (perception group); Group 2 estimated by lifting on a dynamometer (action group). Each participant observed 25 lifts (5 weights  $\times$  5 duplications). There were significant main effects for group, strength, and weight, and there was an interaction between group and strength. Participants in the action group estimated mass significantly higher than those in the perception group, and the strong participants estimated mass higher than the normal and weak ones. The strong participants were able to estimate known masses using the dynamometer just as accurately as the normal and weaker ones. This indicates that strong participants estimate mass higher, not because they underestimate their strength but because they perceive mass heavier when action is involved. Thus, individuals scale perceived mass to their capabilities.

### **Orientation Methods and Weight Training Technique**

Short, M., and C. Grenz. University of North Dakota

The purpose of this study was to determine whether a distributed orientation to free weight and machine exercises was more effective than a massed orientation when evaluating weight-training technique. Healthy students were randomly divided into massed and distributed orientation conditions and were taught 9 exercises. The massed group was oriented to all 9 exercises in one session. The distributed group was oriented to 3 exercises per session during 3 sessions, 48 hours apart. Forty-eight hours after the orientations in which the exercises were completed, the participants were videotaped performing 4 exercises. After completion of the videotaped test, two judges rated the participants using a 9-point scale of common mistakes seen in each exercise. There was a significant difference between the overall rating scores of each group. The distributed group had greater mean scores than the massed group on every exercise, and evaluation of the squat exercise revealed that the distributed group scored significantly better than the massed group. In conclusion, when teaching free weight and machine exercises to novices, it may be better to instruct them in a distributed orientation rather than a massed orientation.

### **Differences Between High- and Low-Confident Football Players on Imagery Use and Ability**

Short, S., and M. Short. University of North Dakota

Over the years it has been shown that imagery can be a highly effective performance enhancement technique in sport, and that confidence is the most consistent psychological construct in distinguishing highly successful athletes from less successful ones. This study examined the differences in imagery use and imagery ability by high- and low-confident athletes using the original and a modified version of the SIQ, the MIQ-R, and the TSCI. The modified version of the SIQ permitted a recomputation of SIQ subscale scores according to athletes' perceptions of imagery functions. These perceptions are important to consider because of theoretical and empirical evidence to indicate that a single image can serve different functions for different athletes. Participants in the study were 79 male college football players. They were classified as either "high confident" or "low confident" based on TSCI scores. MANOVAs were conducted separately for the original and the modified SIQ. It was found that high- and low-confident athletes differed in their imagery use and that these results differed according to how the SIQ subscale scores were computed. As an example, high- and low-confident athletes did not differ on their use of MG-M imagery when using the original SIQ, but they did differ from each other when the modified SIQ was used. The results demonstrate the need to assess image function in addition to frequency.

### **Imagery Use in Sport: Mediation Effects for Self-Efficacy**

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The factors that influence whether or not an athlete chooses to engage in imagery are largely unknown. One reason may be the degree of confidence athletes have in their ability to image. This study examined whether efficacy in using imagery could mediate the relationship between imagery ability and imagery use. Participants were 74 female athletes in 6 college sports: basketball, hockey, soccer, tennis, softball, and volleyball. Measures used were the MIQ-R for imagery ability, the SIQ for imagery use, and a modified version of the SIQ for efficacy in using imagery. Athletes reported higher visual imagery ability scores compared to kinesthetic. MG-M imagery was used the most, followed by MG-A, CG, CS, and MS. Athletes were also most confident in their ability to use MG-M imagery, and least

confident in their ability to use MS imagery. Correlations showed that the more the athletes were confident in their ability to use a certain image, the more they used it. Efficacy in using imagery was found to mediate the relationship between imagery ability and cognitive imagery use. These findings are encouraging because they suggest that having a sport psychologist build an athlete's efficacy in using imagery can facilitate the athlete's imagery use, which would ultimately lead to improved performance.

### **Changes in Parkinsonian Gait as a Result of Long-Term Training With Visual Cues**

Sidaway, B., J. Anderson, G. Danielson, L. Martin, and G. Smith. Husson College

In an attempt to improve the slow shuffling gait of patients with Parkinson's disease (PD), researchers have examined the use of visual cues placed on the floor for the patient to step over. These studies have typically used a single bout of training with such cues but have not examined the long-term carryover of using such cues. In the present study therefore, gait velocity, step length, and limb kinematics were examined during month-long baseline, treatment, and retention phases in a 78-year-old woman with PD (Hoehn & Yahr stage III). During baseline she was required to repeatedly walk at her chosen speed and step length (SL) a distance of 10 m for 30 minutes 3 times a week. During treatment, visual cues (masking tape strips) were placed on the walkway. The distance between the strips was initially 110%, and then after 5 days 120%, of baseline SL. In retention the cues were removed and gait was recorded 2, 5, 9, 16, and 30 days posttreatment. Velocity and SL data between and within the three phases were analyzed via repeated-measures ANOVA. Analysis of velocity and SL during the baseline phase revealed that these parameters did not increase after the first day. During the treatment phase, velocity increased across days. SL during treatment, dictated by the visual cues, was 0.59 m initially and then 0.67 m. Significant effects of day were found in retention for velocity and SL. Phase-by-day ANOVAs revealed significant interactions for velocity and SL. Summarizing these analyses, velocity and SL were stable during baseline, improved during treatment, and then maintained this improvement over the month of retention. SL and velocity one month after treatment did not differ from that at the end of treatment. Kinematic analysis revealed range-of-motion changes at the hip and knee during the treatment phase which were maintained throughout retention. Phase-plane analysis indicated that patterns of coordination were more stable in retention than during baseline. Such findings suggest that the repeated use of visual cues in gait training could potentially improve gait in patients with Parkinson's disease.

### **The Effect of Cane Length on the Accuracy of Height Discrimination Using Haptic Perception**

Sidaway, B., A. Champagne, K. Daigle, N. Marcous, A. Nadeau, and E. Pelletier. Husson College

Although the theoretical mechanisms underpinning haptic perception have been widely studied (e.g., Barac-Cikoja & Turvey, 1991; Chan & Turvey, 1991), the applied implications of such research are not often considered. The basic research literature has generally found that the accuracy of haptic perception is independent of probe length. The purpose of this study was to extend this work to the applied world of environmental negotiation by the visually impaired using canes. We sought to determine whether the ability to haptically perceive object height is a function of the length of the cane being wielded by blindfolded individuals. Two cane lengths (1.22, 1.37 m) are frequently recommended for use for visually impaired adults. These lengths were originally suggested by the U.S. Veterans Administration without any empirical research on the effectiveness of such canes. Fifteen sighted women between the ages of 18 and 25 years volunteered to participate in the study. Five

heights of wooden blocks were haptically explored with four cane lengths (0.92, 1.22, 1.37, and 1.67 m), the order of cane lengths being randomized across 2 days of testing. Participants were asked to report whether the height of the explored block was taller, shorter, or equal to that of a previously presented standard block. The percentages of correct judgments for each cane and block height combination were subjected to statistical analysis. Statistical analysis revealed significant main effects for cane length,  $F(3, 42) = 9.47$ ,  $p < 0.0001$ , and block height,  $F(4, 56) = 17.69$ ,  $p < 0.0001$ . The interaction of cane length and block height was not significant,  $F < 1$ . The accuracy of haptic perception improved with decreased cane length and increased difference in height from the standard block. Contrary to previous research on haptic perception in which probe length was found not to affect judgment accuracy, the present study found a marked influence of cane length on perceptual accuracy. This indicates that length is an important property that should be taken into account when prescribing canes for the visually impaired.

### **Contextual Interference Effect and Manipulation of Generalized Motor Programs and Parameters in Timing Tasks**

Silva, A., G. Lage, W. Gonçalves, L. Palhares, H. Ugrinowitsch, and R. Benda. Belo Horizonte, Brazil

Contextual interference effect (CIE) is only observed when the task variations are governed by different generalized motor programs (GMP) (Magill & Hall, 1990). However, some studies found inconsistent results when verifying this hypothesis. The present study compared the general performance of GMP and parameters (P) groups in a novel task that requires both a new structure of movement and parameter value. Participants ( $N = 48$ ) were randomly divided in 4 groups: random GMP (R-GMP); random parameters (RP); blocked GMP (B-GMP); or blocked parameters (BP). Their task was transporting 3 tennis balls between 6 containers in the same box. All groups practiced 60 trials in the acquisition. The GMP groups performed 3 movement sequences in one target time (2.7 sec). The P groups performed one movement sequence in 3 target times (2.5, 2.7, and 2.9 sec). The transfer and retention tests used the same new sequence and target time (2.3 sec), applied 3 and 10 minutes after the end of the acquisition, respectively. In the test analysis of absolute errors, the two-factor variance analysis (4 Groups  $\times$  4 Blocks) indicated main effects of practice conditions,  $F(3, 44) = 4.25$ ,  $p = 0.010$ . Tukey's post hoc test indicated that the absolute errors were smaller for the RP group than for the BP,  $p = 0.027$ ; R-GMP,  $p = 0.017$ ; and B-GMP groups,  $p = 0.047$ . In the analysis of standard deviation of absolute errors, the two-factor variance analysis (4 Groups  $\times$  7 Blocks) detected no significant difference in Block factor, Group factor, or Groups  $\times$  Blocks interaction. The results did not support Magill and Hall's prediction, because the random practice with the parameter variations compared to GMP variations yielded superior performance in the tests. A possible explanation is that random practice with the same GMP created an optimal interference level in the learning of a novel task.

### **Selective Maintenance of Motor Performance in Elderly Athletes**

Silva, J., L. Teixeira, and E. Lima. Sao Paulo, Brazil

Increased motor performance in active older individuals has been conceptualized as being due either higher physical fitness or to a continuous use of specific sensorimotor functions in the practice of motor tasks. From the former perspective, a higher oxygen supply to the elderly person's CNS would bring about an overall preservation of neuromuscular functions, which should manifest in different motor tasks. From the latter perspective, a selective increased performance would be expected to result from regular training on specific tasks. These hypotheses were contrasted by comparing motor performance of mas-

ter athletes in tennis and running, moderately physically active older persons, and active younger persons. They were compared in a number of motor tasks—simple and choice reaction time, movement time, body balance, manual dexterity, and anticipatory timing—and  $\text{VO}_2\text{max}$ . Among the motor tasks, anticipatory timing was considered to closely match the requirements of tennis, while there was no motor task directly associated with training activities of the elderly runners or the other two groups. Analysis across tasks showed a predominant relationship among groups: superior performance of the younger group over the three older groups, which did not differ from each other. A single important exception was that the anticipatory timing task showed similar performance between the younger group and the elderly tennis players, who were more accurate than the other elderly groups. A higher  $\text{VO}_2\text{max}$  was found for the runners vs. the other two elderly groups, and a nonsignificant correlation ( $r = 0.15$ ) was observed between an index of overall motor performance and  $\text{VO}_2\text{max}$ . These results suggest that only particular sensorimotor functions are selectively preserved in aging by specific and systematic practice, and that a higher capacity of oxygen supply to the nervous system does not significantly improve motor performance in a comparison of active elderly.

### **Stability of Rope Jumping Patterns: Relative Phase and Height of the Jump**

Silva, L.H., F.C. Rodrigues, and A.M. Pellegrini. UNESP, Rio Claro, Brazil

Commonly, there are two different rope jumping modes, alternating the feet (C1) and with both feet simultaneously touching the floor (C2). The question raised was whether both modes show the same stability for relative phase and height of the jump, for different frequencies of the rope. This study focused on the stability of different motor patterns of 8 male university students (M age 23.7 yrs) when jumping rope. The task consisted of 30 consecutive jump cycles, the rope driven by the jumper under conditions C1 and C2 for different frequencies set by an audio digital metronome: 1.5, 1.7, and 1.9 Hz, namely 1, 2, and 3. Performances were captured by a digital camera (120 Hz) for video analysis. In order to obtain data for maximum vertical jump height (MVJH) and continuous relative phase (CRP), we fixed passive marks on the rope at the hip joint and ankle joint. CRP is  $f_{\text{Rope}} - f_{\text{Ankle}}$  at each sequence, with  $f_{\text{Rope}} = \tan^{-1}(\text{velocity/position})$ , according to Kelso et al. (1986). MVJH were normalized to greater trochanter height. ANOVA results indicated that the mean MVJH for C2 (17.12 cm) was higher than C1 (15.02 cm),  $F(1, 7) = 12.87, p < .05$ , and that there was significant difference between frequencies 1.5 and 1.7 Hz, (14.24 and 17.52 cm respectively),  $F(2, 14) = 7.39, p < .05$ . For the SD of MVJH, neither the main factor nor the interaction reached significance. With respect to mean CRP, the results indicated that neither condition nor frequency reached levels of significance,  $p < .05$ . In terms of SD of CRP, C1 (52.98°) was significantly higher than C2 (22.15°),  $F(1, 7) = 134.07, p < .05$ . In sum, only the SD of CRP indicated stability of the rope jumping when performed with both feet simultaneously touching the floor compared to alternating the feet.

### **Examining the Sensitivity of Computerized Neuropsychological Tests in Detecting the Effects of Concussion**

Skakum, A., C. Broderick, T. Schwiezer, F. Jindani, M. Vogel-Sprott, J. Danckert, and E. Roy. University of Waterloo

Concussions are relatively common in high contact sports such as hockey or football. Player safety depends on determining when it is appropriate to return to play given the physical and cognitive consequences of concussion. Subtle changes in cognitive function postconcussion have been identified using several computerized neuropsychological test batteries. The sensitivity of two such tests (Cogstate and Impact) in detecting changes in

cognitive function was examined using alcohol (ETOH) intake as a surrogate for the effects of concussion. In separate sessions for Cogstate and Impact, participants were tested at three time periods: prior to ETOH intake and at 0.08 blood alcohol content on the ascending and descending limbs of the dose response curve. The stated aim of these tests is to detect change in function at an individual level, so we calculated reliable change indices (RCI) for each participant on each subtest of Cogstate and Impact (significant RCIs indicate deterioration in performance). For Cogstate, 3 of 16 subtests demonstrated significant RCIs on accuracy measures in 5 or more of the alcohol group ( $n = 10$ ), while 5 of 16 tests demonstrated significant RCIs for reaction time (RT). For Impact, no subtest detected 5 or more significant RCIs for accuracy measures (i.e., only 2 participants in the alcohol group demonstrated significant RCIs on measures of accuracy for any subtest), while 5 of 12 subtests demonstrated significant RCIs for RT in 5 or more participants ( $n = 10$ ). The implications of these findings for detecting change to cognitive function in concussion is discussed.

### **Developing Perceptual Skill in Tennis Through Explicit, Guided-Discovery, and Discovery Methods**

Smeeton, N.J., A.M. Williams, N.J. Hodges, and J. North. Liverpool John Moores University

In sport, perceptual skill has been shown to be a critical feature underlying expertise. Despite its importance, methods for training perceptual skill have received little attention. In this study 3 groups of young tennis players ( $n = 25$ ) underwent 4 weeks of anticipation training. An explicit-rules group received instruction as to the important postural cues for anticipation and how these cues were related to shot location. A guided-discovery group was only directed to postural cue locations. The discovery group was encouraged to detect anticipatory cues but received no specific instruction. A fourth, no-practice control group ( $n = 9$ ) was only examined pre- and postpractice. Performance was measured pre- and postpractice in the laboratory and on-court, during practice, and postpractice under anxiety-provoking conditions. Time to respond to the shot and decision accuracy were the dependent variables. Differences between experimental groups were shown in practice. The explicit-rules and guided-discovery groups showed rapid improvements in response time compared to the discovery learning group, as evidenced by a Group  $\times$  Day interaction. However, while a significant pre- to posttest difference in response time was observed in the laboratory and on court, in the posttest there were no differences between the 3 experimental groups, but all improved relative to the control. In the anxiety-provoking transfer test, a significant Group  $\times$  Condition effect was observed for response time. Only the explicit-rules group was negatively affected by the anxiety manipulation. This finding supports other research in motor learning and instruction, suggesting that the explicit-instruction group reinvested performance with task-relevant knowledge when anxious. In general, these results show that anticipatory cues can be trained through a number of instructional methods. While the method affects acquisition rate and performance under stress, all methods led to improvements in retention.

### **Association of Number of Friends, Perceived Friendship Quality, and Perceived Peer Acceptance With Physical Activity Motivation in Early Adolescence**

Smith, A.L., and S. Ullrich-French. Purdue University

Peers contribute to a variety of psychosocial outcomes, yet little research has explored peer relationships in the physical domain (Weiss & Stuntz, 2004). The purpose of this study was to extend the knowledge base on peer relationships by exploring the association of number of friends, friendship quality, and peer acceptance with physical activity motivation. Because affect is believed to mediate this association (Duncan, 1993; Smith,



1999), the potential mediating role of enjoyment was considered. Sixth- and seventh-grade middle school students ( $N = 264$ ), ages 10 to 14 years, completed reliable and valid measures of the following variables contextualized to the physical domain: perceived relationship quality with a best friend, perceived peer acceptance, enjoyment, and motivation. Participants were also asked to list their good friends. A self-determination index (Vallerand, 2001) was calculated from the motivation subscales for the analyses. A series of regression models were run separately by gender, following guidelines established by Baron and Kenny (1986) for detecting mediation. For boys, a greater number of friends and higher perceived peer acceptance predicted more self-determined physical activity motivation. For girls, higher perceptions of friendship quality and peer acceptance predicted more self-determined physical activity motivation. Enjoyment was supported as a mediator or partial mediator of these significant associations, with findings in theoretically expected directions. For both genders, 29% of motivation variance was explained. Peer variables explained 11% and 7% of motivation variance beyond the contribution of enjoyment for boys and girls, respectively. Overall, the findings suggest that multiple aspects of peer relationships are motivationally salient in the physical domain. The findings also highlight the importance of considering potential mediating variables and gender in research exploring the peer/physical activity motivation link.

#### **Heart Rate Changes During Odorant Administration: Promotion of Cool-Down and Recovery in Athletes**

Smith, J., and B. Raudenbush. Wheeling Jesuit University

An often under-addressed aspect of athletic training, and even casual exercise, is the proper amount of time for cool-down and recovery. However, when ample recovery period is not available, the likelihood of injury and overtraining increases while athletic performance decreases. Previous research has shown that odorants can affect one's mood, motivation, and task performance. Moreover, peppermint odor is linked to enhanced athletic performance, while jasmine odor is a proven sleep aid. These unique odorant characteristics led to their inclusion in the present experiment in an attempt to determine whether jasmine and peppermint odors can enhance athletic recovery. In a within-subjects design, 20 athletes performed a modified version of the Bruce Stress Test protocol on a treadmill for 15 minutes and then completed push-ups until exhaustion. Following 10 minutes of cool-down stretching in a peppermint, jasmine, or no-odor condition, physiological data were recorded and the participant completed questionnaires related to workload demands and mood. In addition, level of vigor was rated over the next 12 hours. Both jasmine and peppermint odors significantly reduced athletes' heart rate following the cool-down period compared to the non-odorized control condition. Such a finding supports the hypothesis that odorants may have a substantial role in naturally and safely expediting recovery from physical exertion.

*Funded by a grant from NASA*

#### **Control of Force Output as a Function of Grip Configuration, Force Magnitude, and Intermittent Visual Feedback**

Sosnoff, J., K. Jordan, and K. Newell. The Pennsylvania State University

The ability to precisely control finger tip forces is essential for the successful manipulation of objects in everyday life. A strong mediator of the magnitude and structure of motor variability is visual feedback concerning motor performance (Slifkin, Vaillancourt, & Newell 2000). Additionally, the manner in which an object is grasped has been shown to impact the force variability (Sharp & Newell, 2000). However, the relationship between biomechanical (grip configuration) and informational (vision) constraints has not been fully investigated. The purpose of this study was to perform a fine-grain analysis on the role of

visual motor processing during 2- and 3-finger grasping in order to determine the interrelation between grip configuration and visual information on the force output of the fingers. Participants performed an isometric grasp with either only the index finger or the index and middle fingers opposing the thumb at 5 and 25% MVC as visual feedback of force output was provided intermittently. Visual information was provided at 8 distinct intermittencies ranging from 25 to .2 Hz. The results showed that variability increased as a function of increased intermittency and force level, but not changes in grip configuration. Regularity of the force output was greater with increased visual intermittency, and this paralleled a narrowing of the frequency structure in the spectral analysis. The index finger was found to have greater irregularity in the 2-finger grip configuration, but only at the smaller values of intermittency. The synchrony between the force output of the thumb and index finger was found to increase as visual intermittency increased, and was highest at the higher force level. The findings show that levels of information and force interact nonlinearly with grip configuration in the regulation of prehension.

### **Changing Throwing Patterns: Instruction and Control Parameter**

Southard, D. Texas Christian University

The purpose of this study was to compare changes in throwing pattern as a result of instruction and scaling up on a control parameter. Eighty right-handed university students volunteered as participants and were categorized into one of four throwing levels. The levels were determined by the degree to which participants utilized the order parameter while throwing with the dominant arm. Throwing levels were equally dispersed among four groups: (1) practice without instruction or scaling up on control parameter; (2) practice while scaling up on control parameter; (3) practice with instruction while scaling up on control parameter; or (4) practice with instruction without scaling up on control parameter. Each participant practiced throwing with the nondominant arm according to group specifications. Practice consisted of 20 throws twice a week for 5 weeks, i.e., 10 sessions. Instruction stressed segmental lag in a proximal-to-distal sequence. The control parameter was velocity of throw. Throwing patterns were determined by the timing of distal segments relative to their proximal neighbors (lag) and differences in peak velocities of adjoining segments. Group  $\times$  Level  $\times$  Session MANOVA resulted in significant main effects and three-way interactions for dependent measures. Generally, each group improved with practice. However, groups that scaled up on the control parameter were able to take advantage of the order parameter in fewer sessions. Results are discussed from a dynamic systems perspective of motor pattern change.

### **Correlates of Structured Physical Activity in Adolescent Males and Females**

Spink, K., K. Chad, M.L. Humbert, N. Muhajarine, and P. Odnokon. University of Saskatchewan

Engaging in regular physical activity has been associated with a number of health benefits for adolescents (Gruber, 1986; MacKelvie et al., 2002). However, it also is clear that levels of physical activity begin to decrease before puberty (Saris et al., 1986) and that this decline continues through high school (Kelder et al., 1994). Further, it appears there are gender differences, with boys being more active than girls (Sallis 1993). The reasons for these gender differences are less clear. The purpose of this study was to examine the correlates of structured physical activity in high and low active adolescent males and females ( $N = 179$  M, 158 F) ages 12–18 years. Participants completed the MAQ-A (Aaron et al., 1995) to assess physical activity. They also were asked to identify any factors that helped them to be active. Factors that emerged were entered into a logistic regression to predict high (KKD

> 8) and low (KKD < 2) physical activity groups for males and females. For males, those mentioning friend encouragement (OR = 6.8), health (OR = 4.2), or coach (OR = 3.9), the odds in favor of being in the high active group were significantly higher than if these factors were not mentioned. There were differences for females in that the odds in favor of being in the high active group were significantly higher if positive group (OR = 13.8) or coach (OR = 13.4) were mentioned vs. not mentioned. These results provide preliminary support for the idea that interventions designed to increase physical activity in adolescents may need to target different correlates for males and females.

*Supported by CIHR FRN43282*

### **Psychometric Properties of the Intrinsic Motivation Inventory (Short Form) With an African American Preadolescent and Adolescent Female Sample**

Stadulis, R.\*, A. Neal-Barnett\*, L. Fender-Scarr, M. MacCracken, R. Gandee, D. Newman, G. Schoffman, B. Sullivan, and J. Silas-Butler. \*Kent State University; University of Akron

Cuddihy, Corbin, and Dale (2002) revised Ryan's (1982) Intrinsic Motivation Inventory of 20 items to a short form containing 8 items (IMI-S). The IMI-S consists of 2 items for each of the four dimensions of intrinsic motivation: perceived competence, effort/importance, interest/enjoyment, and pressure/tension. The validation sample employed by Cuddihy et al. was of high school age. The present study attempted to determine if the IMI-S demonstrated acceptable psychometric properties for a sample of somewhat younger respondents and representing a specific racial group. In situations when administration time may be of concern, the short form would be preferred if reliable and valid measures can be obtained. Urban dwelling, predominantly lower and lower middle class African American girls ( $N = 210$ ), ages 10–15 years, completed the IMI-S at the start of a community based program whose objective was to promote a healthier lifestyle. Those girls who continued with the program were reassessed 4 months later and then again after 8 months. Mean scores for each intrinsic motivation dimension were very similar to those of the older sample in Cuddihy et al. (2002) except that the pressure/tension dimension evidenced lower levels in the current sample. Factor analysis (exploratory, with varimax rotation) of the IMI-S item responses did not support the paired items loading as independent factors. Correlations between paired items representing each dimension were low to moderate ( $r = .317$  to  $.509$ ). Test-retest reliabilities for the four dimension scores also were low to moderate ( $r = .043$  to  $.585$ ). These results call into question the use of the IMI-S with girls, especially African Americans, of middle school age.

### **The Influence of Motivational Climate on Self-Handicapping in School Physical Education**

Standage, M.<sup>1</sup>, D. Treasure<sup>2</sup>, K. Kuczka<sup>2</sup>, and K. Hooper<sup>1</sup>. <sup>1</sup>University of Bath; <sup>2</sup>Arizona State University

The present study examined the influence of perceptions of motivational climate on reported self-handicapping in school physical education. Seventy-one participants ( $M$  age = 11.98 yrs;  $SD = .31$ ; 34 M, 37 F) took part in a running endurance task in one of two experimental conditions: an ego-involving climate or task-involving climate. Initially, demographic information and responses to a goal orientation measure were obtained. Following a brief introduction to the task, audiotaped inductions were used to facilitate the intended manipulations and diminish any effects related to interpersonal factors (e.g., experimenter's mood, tone of voice). Prior to participating in the experimental task, assessments of task importance, perceived ability, and responses to a list of claimed self-handicaps (Hausenblas

& Carron, 1996; Rhodewalt et al., 1984) were obtained. Following the experimental trial, participants responded to a manipulation check to assess the degree to which they perceived the experimental setting to be task and/or ego involving. Results obtained for the manipulation check revealed that participants held differing perceptions of the treatment conditions which were commensurate with the manipulation they had experienced (both  $p < .001$ ). After determining the effectiveness of the experimental manipulation, results of an independent  $t$ -test revealed that students in the experimental task in the ego-involving setting reported significantly more self-handicapping claims than those exposed to the task-involving condition,  $t(69) = 2.26, p < .05; g = .55$ . Further, and after controlling for important individual difference variables (gender, goal orientations, task importance, perceived ability), the results of hierarchical regression analysis revealed that perceptions of an ego-involving climate positively predicted reported self-handicapping ( $\beta = .43, p < .001$ ). No significant gender differences emerged with regard to reported self-handicapping. Practical and theoretical implications of the findings are discussed.

### **Goal Orientation and Flow Theory: Does Athletes' Orientation Affect Optimal Experience?**

Stavrou, N., M. Psychountaki, and Y. Zervas. Athens, Greece

Research findings on the relationship between goal orientation and flow theory are limited. The purposes of this study were to (a) examine the relationship between task and ego orientation and flow experience, and (b) explore the possible overlap between the orthogonal models of goal orientation theory and flow theory. A total of 362 athletes (204 M, 158 F) ranging in age from 16 to 38 years participated in the study. First they completed the Task and Ego Orientation of Sport Questionnaire in a noncompetitive situation. Then they completed single-item scales of challenge of the competition and their perceived skills one day and 30 minutes before the competition. Third, they completed the two single-item scales as well as the Flow State Scale (FSS) 15 minutes after the competition, based on how they felt during the competition. The results indicated significant correlations among the task orientation and the FSS factors, whereas no correlations were revealed among the ego orientation and the FSS factors. Median splits on ego and task orientation scales revealed significant differences in all FSS factors among the groups of low task/low ego, low task/high ego, high task/low ego, and high task/high ego. The athletes in high task/low ego and high task/high ego groups indicated the highest FSS factor scores. Regarding flow theory, significant differences were found among the FSS factors of apathy, anxiety, boredom, and flow groups (median splits on challenge and skill scales). When both theories were examined jointly, it was found that the athletes in the low task/low ego orientation experienced apathy, those in the high ego/low task group experienced either apathy or flow, and the athletes in the high ego/high task group experienced mainly flow. These findings suggest that goal orientation theory may be relevant and applicable to the study of flow experience.

*Supported by the Greek State Scholarships Foundation*

### **No Evidence for Expectation Biases Based on Flight Order in Figure Skating Judging**

Ste-Marie, D.M., and S.E. Clark. University of Ottawa

Research on gymnastic judging has consistently shown a within-team order effect whereby the same gymnastic performance is awarded a higher score if judged near the end of a within-team order as compared to early in the order (e.g., Scheer & Ansorge, 1975, 1979). This effect was argued to be induced by the judges' expectations that gymnasts appearing late in a within-team order in competition were the better gymnasts than those appearing early in the order. The figure-skating arena has a similar situation wherein skat-

ers' placements to a flight are based on the score of their performance in the short program. Skaters with higher scores perform in the late flights and those with lower scores skate in the early flights of the competition. We tested whether this created an expectation bias on the part of the judges. Twelve judges scored 15 long programs, arranged in three flights of five competitors, on two separate days. Unbeknownst to the judges, we switched the performance of two skaters' positions in the flights, such that a skater judged in the third flight on Day 1 was now in the first flight on Day 2, and vice-versa for another skater. Two skaters were also switched within a flight. Regardless of flight and position within a flight, the skating performances received similar artistic, technical merit, and ordinal scores, indicating that no biases were evident. However, we are still not convinced that we have tested this possible bias adequately. Discussion will center around the difficulties of tapping into such biases in a laboratory setting.

### **Social Physique Anxiety: Does Friendship Matter?**

Stevens, D., and H. Strong. Brock University

Epstein (1989) argued that common social traits are fundamental considerations when choosing friends. The influence of peers has been identified as essential to understanding adolescent behaviors (e.g., cigarette smoking), attitudes, and values (Ennett & Bauman, 1994). However, it is only minimally understood in relation to body related concerns, specifically social physique anxiety (SPA). Using a scenario protocol, Carron and Prapavessis (1997) demonstrated that being with friends was associated with reduced SPA. Further, Carron and colleagues (1999) suggested that these reductions may be due to the perception of decreased individual evaluation when with friends. The purpose of the present study was to further examine the peer influence variables on SPA. A total of 375 adolescents (181 M, 194 F) completed multi- and single-item friendship measures and the Social Physique Anxiety Scale (Hart, Leary, & Rejeski, 1989). Separate analyses of variances revealed that SPA did not differ based on peer group exclusivity for boys or girls,  $p > .05$ . Significant differences were found based on the size of the peer group,  $p < .05$ . A significant multiple regression was found for the extent to which the peer group discussed physique-related concerns and SPA for boys,  $R^2_{adj} = .07$ ;  $F(3, 170) = 5.02$ ,  $p < .05$ , and girls,  $R^2_{adj} = .06$ ;  $F(3, 185) = 4.76$ ,  $p < .05$ . Finally, chi-square analyses demonstrated that girls perceived greater pressure to be thin both from their peer group and those not identified as friends than boys did. Results are discussed with specific attention to the role of group membership on social physique anxiety.

*Supported by Social Sciences and Humanities Research Council of Canada (SSHRC)*

### **Identifying Trunk Kinematic Constraints in Overarm Throwing Development**

Stodden, D.<sup>1</sup>, and G. Fleisig<sup>2</sup>. <sup>1</sup>Bowling Green State University; <sup>2</sup>American Sports Medicine Institute

This study examined children's trunk motions in overarm throwing using both a component analysis (Robertson & Halverson, 1984) and a biomechanical analysis to quantify and identify kinematic differences between component levels of throwing. Forty-eight children (33 boys and 15 girls, mean age 9.8 yrs  $\pm$  3.3) participated in the study. They were tested on 3 to 5 maximal effort throws. Trunk motions of each child were categorized into three developmental levels. Component level data were collected from two 60-Hz video cameras set at perpendicular angles to the thrower. Five kinematic measures defining motion of the pelvis and upper torso (maximum pelvis angular velocity, max upper torso angular velocity, max pelvis linear velocity, max upper torso linear velocity, trunk tilt forward at release) and ball velocity were also calculated using 3-D high-speed motion analysis (240 Hz) for each throw. Kinematic measures and ball velocity were used to compare quantita-

tive differences between component level classifications. One-way ANOVAs were conducted on each kinematic variable and ball velocity to examine differences between component levels. Post hoc analyses were also conducted to determine where the specific significant results occurred between levels. ANOVA results showed significant differences between component levels in all 5 kinematic variables and ball velocity,  $p < .001$ . Post hoc tests revealed significant increases with each increasing component level in all 5 kinematics variables and ball velocity, with the exception of forward trunk tilt at release. These results suggest that the generation and transfer of both linear and rotational momentum within the trunk are important characteristics for viewing developmental change in overarm throwing.

### **Factors Influencing Perceptions of Physical Self for Children and Adolescents: A Concept Model**

St. Onge, P., D. Treasure\*, and A. Guarino. Auburn University; \*Arizona State University

Perceptions of physical self have been linked to body mass index (BMI), body image, social physique anxiety, self-esteem, physical activity behavior, and eating behavior. This issue is of present concern since the link between childhood and adolescent overweight and obesity are associated with reduced mental health and increased disease and morbidity. The purpose of the present study, therefore, was to explain the relationship among these variables for children and adolescents and to design a model that identifies the variables that contribute to health-related behaviors. Participants, 69 children ( $M$  age = 9.75 yrs;  $SD$  = 0.85), and 56 adolescents ( $M$  age = 15.24 yrs;  $SD$  = 1.04) completed a Body Image Scale composed of age and gender-appropriate silhouette drawings, the Social Physique Anxiety Scale, the Children and Youth Self-Perception Profile, a Physical Activity Recall interview, and the Children's version of Eating Attitudes Test. A model was developed consisting of four concepts: (1) BMI; (2) Body image, comprising body image satisfaction and social physique anxiety; (3) Self-esteem, including all scales of the Children and Youth Self-Perception Profile; and (4) Behaviors, physical activity, and dietary restraint. To assess whether the path coefficients operated equivalently across both groups (Children and Adolescent), all path coefficients were constrained equal to each other; the chi-square test for differences demonstrated that the covariance structure was variant between the two groups. Specifically, the Children's group reported a greater negative relationship between BMI and Body Image than the Adolescent group. The Adolescent group indicated a greater negative correlation between BMI and Self-esteem than the Children's group. Body image was positively correlated to Behaviors for the Children's group while negatively related for the Adolescent group. Self-esteem was positively associated to outcome for the Adolescent group, but no significant relationship was found for the Children's group.

### **Examining Thoughts About Exercise in Previously Sedentary Obese Women**

Strachan, L.<sup>1</sup>, K. Munroe-Chandler<sup>1</sup>, C. Hall<sup>2</sup>, P.M. Wilson<sup>3</sup>, and W. Rodgers<sup>4</sup>. <sup>1</sup>University of Windsor; <sup>2</sup>University of Western Ontario; <sup>3</sup>Brock University; <sup>4</sup>University of Alberta

There have been many studies examining the effect of physical activity intervention in sedentary obese women (Murphy & Hardman, 1998; Sidman & Corbin, 2003; Wilde et al., 2001). Few studies, however, have explored the cognitive aspect of participation or lack thereof in inactive women. The purpose of this study was to examine previously sedentary women's exercise cognitions. Sedentary obese women were recruited to complete a 13-week group physical exercise program that progressed at a self-selected pace. Upon completion of the program, a focus group was conducted to examine their thoughts and perceptions about exercise. All data were coded using the QSR-NU\*DIST 6 (Nonnumerical Unstruc-

tured Data Indexing Searching and Theorizing, 2002) computer program. Themes emerging from the data were organized into six main categories: perceived barriers to exercise, specific thoughts related to exercising, perceptions of self, triggers to exercise, exercise motives, and group influence. Based on the information obtained in the present study, more effective and appropriate interventions may be developed in order to help sedentary women become more active. Furthermore, results from this focus group may also help to underscore the importance of improving both the physical health of this population and the cognitive aspects as well.

### **The Challenge of Long-Term Exercise Maintenance: Self-Identity and Self-Efficacy**

Strachan, S., J. Woodgate, A. Tse, and L. Brawley. University of Waterloo

Psychosocial factors associated with successful maintenance of long-term vigorous exercise are under-investigated (Rothman, 2000). The most evidence-based self-related concept implicated in exercise adoption has been self-efficacy. However, it exerts less influence in predicting exercise maintenance (McAuley & Blissmer, 2000). By contrast, Maddux (1993) contends that self-regulatory efficacy remains important for maintenance. Further, another self-related factor previously associated with greater levels of exercise participation and implicated for health maintenance is self-identity. Our study's purpose was to utilize these self-related constructs in predicting exercise among long-term maintenance participants. Fifty-four runners from multiple sites who had maintained years of vigorous exercise volunteered ( $M$  age = 39.8 yrs;  $M$  = 8.4 yrs running, 55 min/day, 3 days/week). Measures of self-regulatory efficacy and runner-specific self-identity were assessed at baseline. A modified Blair et al. (1985) physical activity recall questionnaire (PAR) was administered at 4 weeks. After controlling for years of running, a hierarchical multiple regression revealed that scheduling efficacy ( $R^2$  change = .12), barriers efficacy ( $R^2$  change = 0.10), and self-identity ( $R^2$  change = .07) significantly predicted prospective frequency of exercise ( $F = 6.1, p < .001$ ), accounting for 28% of the total variance. A MANOVA comparing high and low self-identity groups on exercise behavior was significant (Wilks'  $\lambda = .593, p < .001$ ). Specifically, those with high self-identity reported more frequent and longer exercise bouts than those with lower self-identity. Among these long-term exercise maintenance participants, variability in exercise frequency can be predicted by self-regulatory efficacy and self-identity, supporting the notion that adhering to a vigorous exercise program is enhanced by ongoing self-regulation.

### **Weber Slope Analyses of Synchronization and Continuation Timing in Repetitive Circle Drawing and Tapping**

Studenka, B.E., and H.N. Zelaznik. Purdue University

In previous experiments we have shown that timing precision in continuous circle drawing was not related to timing precision in repetitive tapping. We have posited that tapping utilizes an event-timing process, perhaps an internal clock. Circle drawing, we posited, utilizes an emergent timing process in which timing results from the control of some other property of movement. In these earlier studies, timing precision was measured during continuation trials, absent a metronome beat. In this experiment we examined the timing precision of 6 right-handed participants during continuation and synchronization. They performed 8 trials in each of 8 conditions, which were formed by a 2 (Hand, unimanual left vs. unimanual right)  $\times$  2 (Task, circle drawing vs. tapping)  $\times$  2 (Timing, synchronization vs. continuation) within-subject design. In the synchronization condition, participants heard a metronome for the entire trial. Under these two conditions they drew circles and tapped with each hand separately. Movements were made over 4 interval durations: 350, 400, 450,

and 500 ms. Participants completed the protocol in four 1-hr sessions over 7 days. We expected the presence of a metronome to have different effects on event-like and emergent tasks. In both tapping and circle drawing, synchronization trials were temporally more variable than continuation trials. This effect was clear in the right (dominant) hand but was less clear in the left hand. In the latter case, the effect of the metronome appears to be more robust at shorter durations. Furthermore, left-hand timing shows a steeper Weber slope than right-hand timing. These small effects provide marginal support that the timing aid of a metronome will cause an emergent timing task to become event-like.

### **Playing Experience as a Source for Coaching Efficacy**

Sullivan, P., and C. Gee. Brock University

Coaching efficacy refers to the confidence coaches have in their abilities to successfully influence their athletes' abilities and subsequent performance. This is a multidimensional construct referring to four interrelated factors of confidence: teaching technique, strategy, motivating, and character building. Preliminary research suggested that coaching experience is one of the primary sources of coaching efficacy. The current research was designed to assess the relative importance of previous playing experience as a predictor of coaching efficacy. A sample of curling coaches ( $N = 81$ ) completed the Coaching Efficacy Survey (CES) (Feltz, Chase, Moritz, & Sullivan, 1999), which measures the above four factors of coaching confidence. Preliminary analyses supported the internal consistency of the four CES factors and also upheld the assumptions for multivariate data analysis. Four hierarchical regression models were run, with each CES factor as a dependent variable. By partialling out (i.e., statistically controlling for) the effect of coaching experience, these models ascertained the independent contribution of playing experience to coaching efficacy. For the prediction of strategy, playing experience was responsible for a significant improvement in the model over the prediction of coaching experience,  $\Delta R^2 = .091$ ,  $F(1, 66) = 7.98$ ,  $p < .01$ . Coaching experience was the sole significant predictor of all other CES factors. These results show that playing experience may be a significant independent source of coaching efficacy, particularly for those aspects of coaching that involve the application of practical game skills and knowledge. These results may be limited by the specifics of the present sample, and future researchers would do well to try and replicate this finding and further articulate the sources of coaching efficacy.

### **A Dissociation Between Pattern Stability and Central Cost of Interlimb Coordination**

Summers, J., B. Cayoun, S. Elder, H. Fujiyama, and C. Hiraga. University of Tasmania

Recently a direct relationship has been shown between the dynamic landscape of interlimb coordination and the attentional cost of maintaining pattern stability (Temprado et al., 1999; 2001). Support for the covariance between stability and central cost has come from studies of bimanual coordination using a dual-task paradigm in which participants performed rhythmic forearm pronation and supination movements while responding to a secondary discrete probe RT task. Probe RT was shown to covary with the variability of relative phase (RP), a measure of pattern stability. Three experiments are presented examining the central costs of interlimb coordination in a multijoint circle drawing task. In Experiment 1 the participants performed symmetrical and asymmetrical coordination patterns at two frequencies (2/3rds critical, critical [CF]) while responding to randomly presented auditory probes with the feet. An unexpected finding was that although the coordination patterns exhibited decreased stability with increases in movement frequency, probe RT also decreased with increased frequency. Experiment 2 examined the possibility that the slower probe RT at the lower frequency reflected increased visual monitoring of hand trajectories



around the circle templates. Circle drawing performance and probe RT (bipedal vs. vocal response) were compared with and without circle templates at the two frequencies. The template manipulation did not significantly affect probe RT. However, vocal probe RT was significantly faster at the CF than at 2/3rds CF. Bipedal probe RT did not differ across the two frequencies. Experiment 3 examined dual-task performance across a range of frequencies: 20, 40, 60, 80, 100, and 120% CF. While probe RT exhibited a quadratic function across frequencies, coordination pattern stability decreased with increased frequency. These results do not support a direct relationship between pattern stability and central cost. Possible mechanisms underlying the frequency effect will be discussed.

*Supported by the Australian Research Council*

### **Could "Preferred Intensity" Exercise Buffer the Negative Psychological Effect of Passive Stress?**

Szabo, A. The Nottingham Trent University

The psychological benefits of exercise are well known. Research consistently shows that affect improves even after a short bout of physical exercise. Such findings led researchers to speculate that exercise has stress-buffering capacity. However, no studies have tested the effects of exercise on recurring stress experiences such as exposure to images of war on television. Further, the stress-buffering effect of exercise performed at a participant-selected or preferred workload is unknown. Therefore this study tested whether a session of exercise, completed at participants' preferred workload, could improve affect, and therefore buffer the negative effects of laboratory-induced stress experienced prior to the exercise. Thirty participants were tested weekly in 3 counterbalanced sessions: (1) viewing 30 war images during a 5-min period followed by 20 min of sitting quietly; (2) viewing 30 war images during a 5-min period followed by 20 min of stationary cycling; and (3) viewing 30 neutral images of urban architecture (no stress) during a 5-min period followed by 20 min of cycling. State anxiety (SA) was measured with Spielberger's State Anxiety Inventory (SAI) and a total mood disturbance (TMD) score was calculated from the Profile of Mood States Inventory (POMS). Participants completed the two inventories three times in each session: (a) before viewing the images (baseline); (b) immediately after viewing the images; and (c) 20 min later, after either sitting quietly or exercising. The results showed that participants chose to exercise at low intensities in both conditions (mean heart rates = 111 and 112, respectively). As expected, the results also revealed that the watching of war images triggered increases in SA and TMD. Participants' TMD was significantly lower after the exercise session following stress exposure than after the sitting session following stress exposure, but the reverse was observed for SA. Based on the observed changes in TMD during the 3 experimental sessions, it is concluded that a 20-min bout of self-selected or preferred intensity exercise accelerates the reduction of acute mood disturbance caused by viewing images of war.

### **Effects of Visual Motion Illusion on Manual Aiming**

Tanaka, T., T. Higuchi, M. Ishihara, and K. Imanaka. Tokyo Metropolitan University

We examined likely effects of motion after-effect (MAE) on manual aiming. In producing MAE, participants were first exposed for 30 sec to an adaptation stimulus (a set of vertical black and white sinusoidal gratings) drifting (12.5°/s) in a left or right direction within a window (6 × 6 cm) on a computer monitor. After the exposure, a stationary test stimulus (same as the adaptation stimulus, with weaker luminance contrast) was presented to produce an MAE, under which the participants perceived a short-lived (6 or 7 sec) illusory motion of the test stimulus in a direction opposite the adaptation stimulus. Manual aiming was performed at an ex-location of a target (a particular white band of the test

stimulus) in the window as soon and accurately as possible when both the test stimulus and target disappeared. Experiment 1 examined the effect of adaptation exposure on manual aiming. Manual aiming was clearly biased in the same direction as the adaptation stimulus. Experiment 2 examined the effect of MAE on manual aiming. The test stimulus was presented for 1, 3, or 6 sec after the 30-sec exposure to the adaptation stimulus, thus inducing different intensities of MAE. Manual aiming was not biased by the MAE, whereas reaction time (RT) was significantly shortened under the MAE conditions compared with a control condition (i.e., the adaptation stimulus remained stationary). Experiment 3 examined whether the shorter RTs should appear under MAE conditions alone or also occur with real motion of the test stimulus moving at a speed (about 0.4°/s) of the induced MAE. Manual aiming under the real-motion condition was clearly biased toward the real motion but did not show any shortened RTs. In conclusion, it is likely that the spatial control of manual aiming at an illusory moving stimulus is not mediated by conscious motion perception but rather relies on the actual physical position, and that the MAE may affect only *temporal* rather than *spatial* aspects of manual aiming.

### **Defining the End of the Reach Phase in Natural and Remote Prehension**

Tao, A., B. Zheng, and C. MacKenzie. Simon Fraser University

When studying prehension, temporal measures such as movement time commonly provide information about task performance. Since these measures depend on the definition of the start and end of the prehensile movement, it is important to ensure that kinematic data are clipped in an appropriate fashion. A methodological study was conducted to determine the most accurate way to define the end of the reach phase in a reach, grasp, and lift task. Two methods were compared: (a) when the object being moved exceeded a predetermined criterion velocity, or (b) when a stable opposition was formed, when the aperture between the end effectors became constant. Participants were asked to reach, grasp, and lift an object from a wide or narrow base, using either the hand (natural condition) or a tool held in the hand (remote condition). Over all conditions, initial object movement occurred before the formation of a stable opposition, indicating that participants pushed the object into grasp. As well, the time difference between initial object movement and stabilization of aperture varied significantly between natural and remote prehension. Specifically, there was a longer latency when the bare hand was used compared to when a tool was used. This suggests that opposition formation was influenced by haptic and mechanical constraint differences between the natural and remote conditions. Therefore, object velocity is a better method for defining the end of the reach phase in prehension.

### **Anticipatory Skills and Expertise in Cricket Batsmen**

Taylor, M., and A. McRobert. University of Teesside

Fastball sports such as cricket place severe spatiotemporal constraints on participants. This study aimed to highlight what visual information expert cricket batsmen use and when they extract such information from the visual display. Fourteen cricket batsmen took part in the study either as an expert ( $n = 7$ ) or novice ( $n = 7$ ). Movement-based response measures assessed the batsmen's ability to retrieve information from memory in a rapid and efficient manner by measuring initiation time (IT), movement time (MT), response time (RT), and response accuracy (RA). Utilizing the temporal occlusion technique, Experiment 1 revealed that expert batsmen were significantly better at predicting delivery type when the film clips were occluded at 80 ms prior to ball release. Adopting the spatial occlusion technique, Experiment 2 suggested that the bowling arm and ball revealed the greatest decrement in RA for both groups when it was occluded. Finally, results suggested that expert batsmen were able to demonstrate superior ITs, MTs, and RTs without a loss in RA.

### **Are the Elderly Able to Appropriately Reprogram Their Actions?**

Teixeira, L., M. Franzoni, and J. Silva. Sao Paulo, Brazil

Movement reprogramming was examined in young (18–30 yrs) and elderly (60–70 yrs) individuals in a task that required tapping a force transducer at the end of an electronic trackway simultaneously with the arrival of a luminous target. Before the main part of the experiment, participants were familiarized with the task by performing 100 trials under constant velocity associated with instantaneous knowledge of results about temporal accuracy. The time course of movement reprogramming was assessed after familiarization by introducing blocks of trials in which target velocity was unexpectedly reduced from 3 m/s to 2 m/s. This reduction of target velocity took place at different moments before target arrival, which produced times-to-arrival after velocity reduction (TAVRs) between 150 ms and 750 ms. To assess the effect of uncertainty on movement reprogramming, we compared conditions of 25% and 50% of probability of velocity change in both age groups. Analysis of algebraic temporal error in conditions of changed velocity showed an increment of temporal error for all groups up to TAVR = 300 ms. When TAVRs were longer, the younger participants showed a progressive improvement of performance, reaching the highest temporal accuracy at TAVR = 750 ms, which was similar to that observed under constant velocity. The elderly participants, to the contrary, did not significantly improve their performance with longer TAVRs, presenting large temporal errors even with 750 ms to reprogram their movement. No significant effect of uncertainty was observed in either age. Analysis of trials in which velocity was unchanged revealed that both age groups were sensitive to the potential disturbance of the time of velocity change. These results indicate that timing reprogramming is impaired with aging, independent of probability of target velocity change.

### **The Continuous Nature of Timing Reprogramming in an Interceptive Task**

Teixeira, L., E. Lima, and M. Franzoni. Sao Paulo, Brazil

In order to deal with unexpected environmental changes that modulate behavior, an original motor program has to be replaced by another one in accordance with the changed features of the environment. This process is called motor reprogramming. The time course of movement timing reprogramming was examined in a task requiring temporal coincidence of the conclusion of a forehand drive with the arrival of a moving luminous target at the extremity of an electronic trackway. The moving target departed from one extremity of the trackway at a constant velocity of 2 m/s, and in part of the trials its velocity was unexpectedly and instantaneously increased to 3 m/s. Target velocity was increased at different moments before the target arrival at the interception point, which produced times-to-arrival after velocity increment (TAVIs) between 100 ms and 600 ms. The effect of specific practice on movement reprogramming was also examined by providing participants with 600 practice trials under constant or changed velocity conditions. The results showed early adjustments to the action (TAVIs = 100–200 ms) which seemed to be stereotyped, while more effective feedback-based corrections were implemented only at TAVIs = 300 ms or longer. Most movement timing correction was accomplished at TAVI = 400 ms, but the reprogramming process was apparently concluded only at 600 ms following velocity increment. Practice led to an overall increment of temporal accuracy in the posttest, but no difference was found between groups. As the main conclusion, these results indicate that reprogramming of interceptive actions is a continuous process limited mainly by intrinsic factors: latency to initiate more effective adjustments to the action, and rate of movement timing reprogramming.

### **Dynamics of Learning and Transfer of Muscular and Spatial Relative Phase in Bimanual Coordination: Evidence for Abstract Directional Codes**

Temprado, J.J.<sup>1</sup>, and S. Swinnen<sup>2</sup>. <sup>1</sup>Université de la Méditerranée; <sup>2</sup>Katholieke Universiteit Leuven

The present study addressed whether the timing of muscle activation and relative direction of limb movements are dissociable constraints that may affect learning and transfer of bimanual coordination patterns, either independently or in combination. Participants were assigned to two experimental groups in which the to-be-learned muscular phasing (135°) was either practiced with 45° (i.e., predominantly isodirectional) or 135° (predominantly nonisodirectional) of spatial relative phase across 2 days of practice. Prior to, during, and following practice, probe tests were conducted in which various relative phasing patterns were administered to assess transfer of learning. Converging evidence was obtained that the relative direction of moving limbs prominently constrained transfer of learning rather than muscular relationships. Acquisition of a specific pattern resulted in spontaneous positive transfer of learning to a new coordination pattern having the same spatial relative phase, but not to a pattern with a different spatial relative phase, regardless of muscular phasing relationships. In summary, the present results suggest that learning and transfer of coordination patterns is mediated by abstract directional codes that become part of the dynamics of bimanual coordination.

### **Age and Physical Activity Effects on Error Monitoring**

Themanson, J., C. Hillman, and J. Curtin\*. University of Illinois; \*University of Wisconsin

Decrements in cognitive processing have been commonly observed in older adult populations, with greater declines found for processes that involve extensive executive control, which refers to a subset of cognitive processes that entail the intentional component of environmental interaction. However, physical activity (PA) participation has been found to ameliorate certain cognitive declines observed in older adults, suggesting a beneficial relationship between physical activity and cognitive health. Thus the relationship of age and PA on error monitoring, one component of executive control, was explored by placing 66 participants (33 women) into one of four groups: older-active, older-sedentary, younger-active, younger-sedentary. A task-switching paradigm was used to compare behavioral and neuroelectric indices of correct and incorrect responses. This task consisted of two blocks of pure conditions (less than or greater than 5, odd-even digit) and two blocks of switch conditions (switching between pure conditions). Results indicated that older adults, vs. younger adults, had slower reaction time (RT) and decreased error monitoring, as measured via the error-related negativity (ERN) component. Sedentary adults had slower RT compared to PA adults, only for correct responses. For incorrect responses, the neuroelectric findings revealed that sedentary adults exhibited increased ERN compared to PA adults. Finally, no such age or PA effects were observed during correct responses for the ERN. The findings suggest that both age and PA influence underlying neuroelectric activity during error monitoring for tasks involving extensive executive control, and further suggest that PA may be associated with greater neuroelectric efficiency during error monitoring.

*Supported by NIH RO1 AG021188*

### **EEG Correlates of Traumatic Brain Injury in Athletes**

Thompson, J., and S. Slobounov. The Pennsylvania State University

Mild traumatic brain injury (MTBI), or concussion, is one of the least understood injuries facing the sports medicine community. No two injuries are alike in mechanism, symptomology, or resolution. The current gold standard in MTBI assessment is the combined use of: (a) rating scales measuring injury severity, and (b) neurocognitive testing pre- and postinjury. Recent research has shown many shortcomings of these as MTBI assessment tools (Guskiewicz et al., 2001; Shaw, 2002; Warden et al., 2001), and even of imaging techniques such as CT and MRI (Barth et al., 2001; Guskiewicz, 2001; Thatcher et al., 1989, 1997, 2001). Focus has begun to shift to more objective measures, namely balance and EEG measures. Balance testing adds a motor component that makes assessment relevant to sport (Guskiewicz, 2001; Oliaro et al., 2001), while EEG has demonstrated its validity and sensitivity in detecting neuronal structural damage postconcussion (Potter, 2001; Shaw, 2001; Slobounov et al., 2000; Thatcher et al., 1989, 1997, 2001). This paper presents a discussion on the validity of an MTBI assessment that combines balance and EEG testing. The framework we present uses within-subject pre- and postinjury measurements to quantify individual changes in athletes' neuronal functioning following a concussion. EEG recordings performed during balance assessments, using an AMTI force plate and a 3-D moving visual display, reveal important information regarding differences in the neuronal pathways that athletes utilize pre- and postinjury to maintain balance under changing environmental stimuli. This combined balance and EEG testing, applied to a within-subject testing program, would make MTBI assessment and return-to-play measures more accurate, objective, and reliable, benefiting athletes and sport alike.

### **Examining the Ability of 3-Month-Old Infants to Learn to Increase Alternate Kicking**

Tiernan, C., and R. Angulo-Barroso. University of Michigan

Early alternate leg movements are deemed important for subsequent locomotor skills. While previous literature has demonstrated that 3-month-old infants can increase single kicks to meet task demands, little is known about their ability to increase alternate kicks. Kicking patterns at 3 months of age have been described as unstable and thus susceptible to contextual manipulations during this transitional period. Therefore the goal of the current study was to determine whether 3-month-old infants could learn to increase their production of alternate kicking, a nonpreferred pattern, using a constrained mobile procedure over a 2-day period. Day 1 consisted of a 2-min baseline followed by 10 min of acquisition in which infants received mobile reinforcement for alternate kicks. Day 2 began with 10 min of acquisition and ended with a 2-min extinction period. Fourteen infants were randomly assigned to one of two groups: pulley (to facilitate alternating kicking), and no pulley. Infant sessions were videotaped and analyzed to determine frequency of kick types, arousal, and attention. We conducted  $2 \times 2 \times 6$  (Group  $\times$  Day  $\times$  Block) ANOVAs and extinction to baseline ratios for alternate kicks. Results revealed a significant block effect,  $F(1, 8) = 3.204, p = 0.023$ , with a significant linear trend,  $F(1, 12) = 11.86, p = 0.005$ , and a trend for Block  $\times$  Group interaction,  $F(1, 8) = 2.943, p = 0.085$ , for alternate kicks. In addition, a one-tailed  $t$ -test revealed that extinction to baseline ratios differed between groups,  $t = 12.71, p = 0.049$ . A significant Group  $\times$  Block effect for total kicks,  $F(1, 8) = 6.796, p = 0.009$ , and a significant group effect,  $F(1, 12) = 4.856, p = 0.048$ , for arousal were also found. It was concluded that both groups increased their level of alternate kicks and the pulley group tended to increase their alternations more than the no-pulley group, although this was not

statistically significant. In addition, the pulley group increased their total kicks more than the no-pulley group, and the groups differed in their arousal levels. Future work should increase sample size and study temperament issues more closely.

### **Effects of Practice on Speed–Accuracy Trade-offs in Manual Aiming**

Tremblay, L. University of Toronto

It is widely accepted that slower movements tend to be more accurate than faster ones (e.g., Fitts, 1954). In fact, speed–accuracy trade-offs can also be observed with discrete manual aiming movements performed without visual feedback (Wallace & Newell, 1983). The goal of the present study was to evaluate the effect of practice on speed–accuracy trade-offs using a movement time manipulation procedure. Twelve participants performed 100 acquisition trials with full vision of their limb within a 450–550-ms movement time (MT) bandwidth. Then they were all transferred to a no-vision (NV) transfer test for 10 trials using the same MT bandwidth as in acquisition (same transfer). Afterward they completed two other NV transfer tests of 10 trials, one with a lower MT bandwidth (slower transfer: 200–50 ms) and one with a higher MT bandwidth (faster transfer: 650–800 ms). As expected, instructions significantly affected MT (slower transfer = 560 ms; faster transfer = 390 ms), and vision withdrawal from acquisition to the first transfer test led to a significant decrease in movement accuracy. Comparison of all three NV transfer tests revealed that, only for the CE in the secondary axis of the movement, slower transfer aiming trials (0.7 mm) were more accurate than faster transfer trials (9.3 mm). On the other hand, the isolated comparison of the slower and faster transfer test data revealed that CE was in fact larger for slower movements (–8.2 mm) than for faster movements (–2.9 mm) in the primary axis of the movement. These results are discussed with respect to three streams of research in manual aiming: speed–accuracy trade-offs (Schmidt et al., 1979), effect of task constraints on accuracy (Carlton, 1994), and control of direction and amplitude (Ghez et al., 1997).

### **The Regularity of Grip Force Output Using Prosthetic and Anatomical Limbs**

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Analyzing the global dynamics of continuous force output has been used recently to help us better understand the control structure underlying movement production. In the current experiment we extend our traditional analyses of upper limb prosthetic control to determine whether there are differences in the dimensionality of the control structure underlying the control of a prosthetic simulator with two types of terminal devices, voluntary opening (VO) and voluntary closing (VC), and the anatomical hand (AH). Ten able-bodied participants attempted to produce three target force levels (0.49, 4, and 10.5 N) for a 15-sec period. They performed 27 trials with vision and 27 without vision. We hypothesized that the VC would perform more closely to the AH due to its logical compatibility to the anatomical hand. An ANOVA on approximate entropy of the force output revealed a significant 3-way interaction among vision, prehensor type, and target force. With vision, the AH showed a large increase in regularity with increase in target force, the VC showed a small increase in regularity with increase in target force, and the VO showed almost no increase in regularity with increase in target force. These profiles were exaggerated in the no-vision condition. These data support our hypothesis and reinforce our previous conjecture that the compatibility between voluntary muscular force and force output influences the ability to modulate force with a prosthesis.

### **The Differential Effects of Practice on the Acquisition of Discrete and Continuous Tasks**

Turner, A.M., D. Goodman, and J. Dickinson. Simon Fraser University

The issue of optimal distribution of practice has been controversial for decades. The current study involved participants acquiring a novel skill and used a double retention test to evaluate learning. This constituted an attempt to resolve conflicting evidence by combining comparison of massed vs. spaced practice using a task with continuous and discrete versions into a single experiment. Thirty-two participants assigned randomly to one of four groups (discrete-massed, discrete-spaced, continuous-massed, continuous-spaced), which differed in the distribution of practice and task type, were tested on a computer tracking task. This novel task involved the movement of two single-degrees-of-freedom joysticks in a coordinated fashion to move a cursor between targets on a computer screen. Participants had to learn the appropriate combination of force and speed to navigate between the targets with the least amount of error. Absolute, constant, and variable errors were assessed. All participants were given 80 practice trials in one session, followed by 20 trials after 5 min to assess immediate retention. They were also required to return one week later for a delayed test of retention which also involved 20 trials. Results for variable error in immediate retention supported previous research in demonstrating that spaced practice resulted in superior retention with continuous tasks, whereas massed practice produced superior immediate retention for the discrete tasks. However, the reverse was the case with delayed retention, i.e., spaced practice was superior to massed for the continuous task, and massed practice was superior to spaced for the discrete task. There was also a significant effect of type of practice when comparing the final acquisition score with performance on delayed retention. Massed practice was beneficial in the delayed retention of the discrete tasks, and there was a deleterious effect on delayed retention with distributed practice for the continuous task.

### **Visual Search Strategies of Rugby Players: Eye Movements During One-on-One Defense**

Ueno, T., T. Fukuda, and T. Kato. Fujisawashi, Japan

The aim of this study was to examine the visual search strategies of experts and non-experts during one-on-one defense in rugby. This study is in a preliminary one to develop a defense methodology of rugby. In this study the eye movements of participants were recorded both in field experiments under a live situation and in a simulation experiment under laboratory settings. The participants were inexperienced players and top college players in Japan. They were asked to view film the stimuli (real action / films) which consist of a ball carrier running straight toward the participant and then suddenly makes a feint move, triggering a reaction from the participant. The results showed that the experts focused on the ball carrier's waist for a relatively longer period than did the non-experts, who instead focused more on the face. This study clarified just how the expert adjusts his visual search strategy to approach the ball carrier as he is prepared to make the tackle.

### **Stabilization of Performance and Disturbance in Adaptive Process in Motor Learning**

Ugrinowitsch, H., U. Corrêa, A. Ugrinowitsch, R. Benda, and G. Tani. Belo Horiz., Brazil

To explore learning as a continuous process with increasing complexity, we used a referential of nonequilibrium in the acquisition of motor skills. In this referential, learning contemplates a process of two phases: stabilization and adaptation. The first involves the stabilization of performance through negative feedback, when a structure is formed and the spatial temporal standardization of the action happens. The second is the formation of more complex structures from the already existing ones. However, it seems that the adaptation in the second phase requires two basic conditions: first, the performance must be stable, and second, the formed structure be broken by inserting a disturbance. Thirty participants underwent a coincident complex task of timing, with two phases: stabilization and adaptation. Two groups were formed: one that performed the task 10 times without stabilizing the performance (PMG), and another group that performed the task until stabilizing the performance, inferred by three consecutive executions of the task with the absolute error equal to or smaller than 30 ms (SMG). All participants performed 25 more executions of the new task (adaptation phase). The two-way (2 Groups  $\times$  6 Blocks) ANOVA with repeated measures in the second factor with the last block of the stabilization phase and the five blocks of the phase of adaptation for the absolute error identified a significant effect in the interaction between the two factors,  $F(5, 140) = 4,583$  and  $p < 0.001$ . Tukey's test revealed that the SMG had superior performance than the PMG in the last block of stabilization,  $p = 0.001$ , and that the first block of adaptation of the PMG presented inferior performance in all blocks of the GEM in the same phase. Significant difference for the variable error in all factors was not detected. The results show that for the measure of performance, without the stabilization, there will be no adaptation.

### **EMG Activity as a Function of the Performer's Focus of Attention**

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The performance and learning of motor skills has been shown to be enhanced if the performer adopts an external focus (movement effect) compared to an internal focus of attention (movements themselves). However, previous studies examining attentional focus effects have almost exclusively used performance outcome measures. In the present study, EMG was used to determine whether external vs. internal focus differences would also manifest themselves at the neuromuscular level. Participants performed biceps curls while focusing on the movements of the curl bar (external focus) or their arms (internal focus). The results showed that integrated EMG activity was reduced under external focus conditions. These findings are in line with the "constrained action hypothesis" (Wulf, McNevin, & Shea, 2001), according to which an external focus promotes the utilization of more automatic control processes.

### **Peer Motivational Climate in Youth Sport: Measurement Development**

Vazou, S., and N. Ntoumanis. University of Birmingham

The influence of the motivational climate initiated by peer groups on children's achievement behavior has been highlighted in the sport psychology literature as an area that needs further examination. To this effect, a new measurement of peer climate (Peer Motivational Climate in Youth Sport Questionnaire; PeerMCYSQ) was developed and validated in a series of three studies. In Study 1 the items were written based on the higher and lower order themes of peer climate identified by Vazou, Ntoumanis, and Duda (2003). Explor-



atory and confirmatory factor analysis with 431 British athletes, ages 12–16 years, from a number of sports suggested that the PeerMCYSQ had a hierarchical structure with two higher order factors (task-involving and ego-involving climates), each with three subscales (Task: improvement, relatedness support, effort; Ego: intrateam competition, normative ability, intrateam conflict). In Study 2 the six-factor solution was tested using confirmatory factor analysis (CFA) with an independent sample ( $N = 606$ ) of the same age. The analysis resulted in three good-fitting models with six-, five- (intrateam competition and normative ability combined) and four-factor models (as in five-factor solution but without effort). The latter model had the best fit. Because some factor correlations in the three models were very high ( $r > .800$ ) and the internal reliability of some other factors in the six-factor solution was low, a third study was conducted to test the models with another sample ( $N = 495$ ). The third study showed similar results in terms of model fitting and internal reliability for all three models, but the factor correlations were smaller. In view of these results, we accepted the four- and five-factor solutions, with the former having a slightly better fit: four-factor,  $\chi^2(98) = 140$ ,  $p < .01$ , RobustNNFI = .97, CFI = .97, RMSEA = .049; five-factor,  $\chi^2(179) = 274$ ,  $p < .001$ , RobustNNFI = .94, CFI = .95, RMSEA = .036. Future research should examine the relative influence of coach and peer climate in various cognitive, affective, and behavioral outcomes.

#### **Motivational Climate in Youth Sport: The Relative Influence of Coach and Peers**

Vazou, S., N. Ntoumanis, and J.L. Duda. University of Birmingham

Research on youth sport motivation has mainly focused on the influence of adults (parent, coach, PE teacher) while peer influence has not received much attention. This is unfortunate since both adults and peers can influence the motivation of young athletes. The purpose of this study was to examine the influence of perceptions of the coach- and peer-created motivational climate on cognitive (self-esteem), affective (enjoyment, trait-anxiety), and behavioral (commitment) outcomes in youth sport. Age and gender differences in athletes' views regarding these psychological environments were also examined. Participants were 493 young athletes 12 to 17 years of age ( $M$  age = 14.08;  $SD = 1.29$ ) from various sports. One-way multivariate ANOVAs revealed that perceptions of ego-involving coach and peer motivational climates were higher among boys, whereas girls reported higher perceptions of task-involving coach and peer motivational climates. Age differences were identified with regard to a perceived ego-involving climate, with younger children (12–13 years) scoring higher on intra-team rivalry (coach climate), and older children (14–16 years) on intra-team conflict (peer climate). Hierarchical regression analyses, controlling for age and gender, showed that a perceived task-involving peer motivational climate was the only predictor of self-esteem and that a perceived ego-involving coach climate was the only predictor of trait-anxiety. Enjoyment and commitment were predicted by both coach and peer task-involving motivational climates, but the latter had stronger effects. The findings provide evidence for the predictive validity of peer motivational climate in youth sport and suggest that both coach and peer climate should be considered in future research.

#### **Determinants of Mental Health Symptomology Among Adolescents and Youth: The Role of Physical Activity**

Vickers, D., N. Muhajarine, K. Chad, K. Spink, K. Anderson, and G. Bell-Woodard. University of Saskatchewan

The purpose of this study was (a) to identify a comprehensive array of correlates that are associated with adolescents' perceived mental health, and (b) to examine the influence of physical activity on the relationship between these correlates and an adolescent's mental

health symptomology. A representative sample of male and female students, ages 12 to 18, was assembled for this study ( $N = 793$ ). Participants were from 9 elementary and secondary schools in Saskatoon, SK, Canada. Trained research assistants administered face-to-face standardized health and physical activity questionnaires to the participants to assess: personal characteristics, family life, health practices (such as physical activity), psychosocial factors, and symptoms of mental health problems. Adolescents who were retained in the analysis ( $n = 632$ ) did not differ significantly from those who were excluded. Logistic regression revealed significant correlates. Girls of Aboriginal descent who performed well academically, had a poor relationship with their parents, low self-esteem, and a poor perceived body image (i.e., overweight or underweight) were more likely to report symptoms of poor mental health. Although physical activity did not significantly affect mental health symptomology as a main effect, moderate levels of physical activity did demonstrate significant effect modification among girls (at  $\alpha = 0.10$ ). Additional interaction analyses revealed that an adolescent's perceived body image was significant among gender categories. This study suggests that key behavioral, psychosocial, and demographic factors influence the mental well-being of athletes. More notably, gender and perceived body image are important effect-modifiers and psychosocial influences on mental health. Despite the fact that physical activity was not a significant main effect of mental well-being, its mild effect modification properties indicate that it may affect gender differently. These findings have important implications to consider when planning and implementing future health-promoting initiatives for adolescents and youth living in urban environments.

### **Striking Similarity in Motivation at Disparate Performance Levels in Soccer: Implications?**

Vikander, N., and B. Welde. Levanger, Norway

Mediaas and Vikander (1999) found in a study of elite Norwegian men's soccer that coaches placed great emphasis on motivation development. In studies of individual sports such as cross-country skiing (Vikander & Margolin, 1989) and swimming (Vikander, Stallman, & Freim, 1992), substantial motivation differences were found favoring higher performance athletes. The present study takes its impetus from these inquiries and examines the motivation patterns of two clubs at widely different performance levels in Norwegian men's soccer: Hyacinth ( $n = 22$ ) in the elite division, and Trost ( $n = 16$ ) of the fourth division. The Achievement Motivations Scale for Sporting Environments (Rushall & Fox, 1977) was administered in its Norwegian version, providing detailed 9-dimension analyses of training, competition, and overall motivation based on the distinction between motivation to succeed and motivation to avoid failure (Gjesme & Nygaard, 1971). Mean scores were virtually indistinguishable between the two clubs on all 9 dimensions, contradicting the findings of the skiing and swimming studies using the same instrument. Score range was generally greater among Trost players, while idiographic data for both clubs showed very large variations. Implications of the findings are discussed in terms of coaching, player development, and the place of motivation generally in the equation of athletic performance.

### **Adaptation to Gradual and Abrupt Change in Sensorimotor Coupling: Auditory Cues and Bilateral Finger Tapping**

Viswanathan, P., C. Horn, T-Y. Chang, R. Roche, and J. Whittall. University of Maryland at Baltimore

The ability to form and adapt sensorimotor coupling can be examined by finger tapping experiments in the presence of a changing external stimulus. The contrast between gradual (imperceptible) and abrupt (perceptible) changes in sensory stimuli was the focus of the present experiment. Our experimental paradigm utilized bilateral alternating tapping.

Ten adults ( $M = 25$  years,  $SD = 1.3$ ) alternately tapped their index fingers for 25-sec trials in time to auditory cues provided through headphones. Sensors were attached to the fingers to measure movements through a magnetic tracking system. Each set of gradual or abrupt change consisted of 6 conditions with 2 trials per condition. After 2 baseline trials wherein signals were antiphase ( $180^\circ$  out of phase), the gradual set consisted of moving one signal  $5^\circ$  (under subliminal perception of the individual) every 2 trials until the beats were  $200^\circ$  (out of phase), after which 2 baseline trials followed to test for aftereffects. The abrupt set consisted of 8 middle trials with a  $20^\circ$  or  $45^\circ$  phasing change, depending on the perceptual threshold of the individual since it had to be a perceptually noticeable change. Prior to the experiment, a psychophysical staircase paradigm was used to determine each individual's perceptual threshold. The 2 trials per condition were averaged and a one-way repeated ANOVA was run on the between-finger phasing relationships. The main results were: (a) individuals showed a range of perceptual thresholds from  $10^\circ$  to  $40^\circ$  ( $M = 21^\circ$ ;  $SD = 10$ ); (b) adaptation to the abrupt condition was immediate and stable over the trial; (c) adaptation to the gradual conditions was less immediate and stable but was statistically evident by the  $20^\circ$  shift; (d) participants who were unable to detect a  $20^\circ$  shift prior to the experiment still adapted in the gradual conditions. These results are discussed in relation to previous studies on unilateral tapping and to Mates' (1994) two-process model of synchronization in which phase changes are assumed to be largely automatic.

#### **A Comparison of Three Movement Settings on the Development of Fundamental Motor Skills in Young Children**

Wall, S., M. Rudisell, J. Goodway\*, and L. Parish. Auburn University; \*The Ohio State University

The purpose of this study was to determine whether different movement setting opportunities influence the development of fundamental motor skills (FMS). It was hypothesized that preschool children receiving movement instruction and modeling, as well as exposure to equipment (IE), would demonstrate more improvement in FMS development than children who were not given instruction but were provided the equipment (EO), or children who did not receive either instruction or equipment opportunities (NO). Three groups ( $N = 74$ ) received one of the three movement-setting opportunities. Before and after the 12-week period, participants were asked to complete the Test of Gross Motor Development-2 (TGMD). Separate  $3 \times 2$  ANOVAs (Groups  $\times$  Time), with repeated measures on the last factor, revealed significant interactions for both TGMD locomotor and object-control subscales. Follow-up analyses indicated that the IE group improved significantly from pre- to postassessment for locomotor and object-control subscales. The EO and NO groups demonstrated little to no improvement between pre- and postassessment for either locomotor or object-control subscales. These findings suggest that the combination of movement instruction, modeling, and equipment are critical for motor skill development, and that young children need more than just equipment to improve their FMS. Overall, the findings imply that young children need movement instruction and modeling from their caregivers if FMS are to be learned.

#### **The Effect of Participation and Performance in Division III College Football on Levels of State and Trait Anxiety**

Walters, P. Wheaton College

The purpose of this study was twofold. First, to compare state and trait anxiety levels between Division III college football players and the general college population not currently participating in varsity athletics. A second purpose was to examine the effect of foot-

ball performance on state and trait anxiety among varsity football players. Seventy four NCAA Division III college football players participated in the study. Each participant completed the State-Trait Anxiety Inventory (Spielberger, 1983) and responded to a questionnaire that identified various performance measures (starters, nonstarters, and amount of playing time). These measures were used to classify subjects into low, moderate, and high performance groups. A single sample *t*-test was used to determine whether there were significant differences between football players and the general student population for both state and trait anxiety. Previous data collected from 324 college males who were not currently participating in any form of varsity athletics were used as the comparison group. A MANOVA was employed to determine whether there were any effects between performance and state and trait anxiety among football players. The results of this study revealed that Division III college football players reported significantly ( $p \leq .05$ ) lower state and trait anxiety levels than did males not participating in varsity athletics. However, no significant differences were found among the athletes based on performance measures.

### **The Relevant Study Between the Category of Leisure Participation and Deviant Behavior of Taipei Adolescents**

Wang, M-S. Taipei, Taiwan

The purpose of this study was to determine (a) the influence of categories of leisure participation and deviant behavior of adolescents on diverse background variables, and (b) the importance of diverse background variables on leisure participation and deviant behavior. The research seeks to further realize the difference between adolescents' participation on different leisure activities and the relationship on different levels of deviant behavior. Participants ( $N = 1,088$ ) were randomly selected using a multistage random sampling method from the junior and high school student populations in Taipei City. The data were analyzed using a modified Leisure Participation and Deviant Behavior Measurement Scale, descriptive statistic, contingency coefficient, *t*-test, one-way ANOVA, Spearman's product-moment correlation and factor analysis. The major findings were: (1) The diverse background variables of adolescents will influence their leisure participation frequency. (2) Variables such as socioeconomic status, gender, achievement, class level, and type of school will likely influence their leisure participation frequency. (3) Except for socioeconomic status, the level of deviant behavior will likely be influenced by other variables such as gender, achievement, class level, and type of school. (4) Deviant behavior will likely influence the type of leisure participation. (5) There is a relevant relationship between the level of deviant behavior and the frequency of leisure participation. Conclusions: The results of this study may provide some insights for reference and research on family education, school administration, and social education in future studies.

### **Target-Related Coordination of Bimanual Reaching Movements**

Weigelt, M., F. Mechsner, M. Rieger, and W. Prinz. Max Planck Institute

In the field of motor control, coupling effects between both hands are often explained by motor coordination, based on intrinsic movement properties. We argue that these effects can also be explained in terms of target coordination, based on extrinsic task properties. To examine this proposal, we had participants move to two of four possible target locations. Target locations were at the same or different distance (Experiment 1), and in the same or different direction (Experiment 2). Circles and crosses served as symbolic target cues and were arranged in a symmetric or nonsymmetric fashion over the four target locations. The results support a target-related coordination account, as movements were always initiated faster to identical targets. In Experiments 3 and 4 we excluded the possibility that the ob-

served effects are due to faster visual processing of identical target cues. Results showed target-related coordination for short and intermediate response intervals. We conclude that action coordination is driven by extrinsic factors that relate to the perceptual goals of the task.

### **Bilateral Transfer and Motor Skill Learning in Schoolchildren**

Weigelt, M.<sup>1</sup>, and O. Senff<sup>2</sup>. <sup>1</sup>Max Planck Institute; <sup>2</sup>Universitaet Jena

This study was designed to investigate the optimal direction of transfer for a motor task demanding high spatial accuracy, as well as to compare different ways to schedule early motor learning practice. Middle school students ( $N = 64$ ) were examined in a cent slide task that required them to slide coins from one side of a cardboard into a circular target on the opposite side. The task was practiced after four practice schedules ( $n = 16/\text{condition}$ ): (1) Participants practiced the skill only with their right hand ( $n = 80$  trials) [Right]; (2) They started to practice the skill with their right hand ( $n = 40$ ) and then switched to their left hand after half of the trials ( $n = 40$ ) [R  $\rightarrow$  L]; (3) They started to practice the skill with their left hand ( $n = 40$ ) and then switched to their right hand after half of the trials ( $n = 40$ ) [L  $\rightarrow$  R]; (4) They practiced the skill only with their left hand ( $n = 80$  trials) [Left]. The results showed that initial practice with the left hand led to greater performance gains, and thus a better learning of the skill. This was demonstrated by the L  $\rightarrow$  R group in a longer retention of the skill, a better transfer to a different testing situation, and the more flexible performance of both hands in a random sequence. We concluded that the initial practice of skills demanding high spatial accuracy with the left-hand side leads to greater bilateral competence.

### **An Optimistic View of Aging: An Analysis of Masters World Championship Swimming Data**

Weir, P.<sup>1</sup>, S. McKay<sup>2</sup>, and J. Starkes<sup>3</sup>. <sup>1</sup>University of Windsor; <sup>2</sup>University of Michigan; <sup>3</sup>McMaster University

The decline of swimming performance in Master athletes has been well documented (Tanaka & Seals, 1997; Weir, Kerr, Hodges, McKay, & Starkes, 2002). The shape of the performance curve has been characterized as having both linear and quadratic components. Making inferences about the aging process by examining these quadratic-shaped performance curves paints a very pessimistic view of aging, that as one gets older, performance declines at an increasing rate. However, age grading has been used in track & field as a means by which performances can be compared against an open or world standard adjusted for age. Thus performances can be compared across events, time, and ages. The current study compared a cross-section of Master's World Championship times for both men and women swimming over 200 and 800m distances. These performance times were also calculated as a percent of the World Record for each respective age group and competition. Performance (time and %) vs. age curves were analyzed using multiple regression. It was hypothesized that age related declines in performance would be lower when performances were standardized to World Record times. The quadratic beta weights were very clear in supporting the hypothesis that performance times displayed a greater rate of decline ( $\beta = .035$ , 200m;  $\beta = .14$ , 800m) than percent World Record data ( $\beta = .004$ , 200m;  $\beta = .004$ , 800m). As further evidence of the maintenance of superior performance with age, the %WR times were categorized according to the standardized achievement levels for track & field. Across both gender and distances, swimmers of all ages had achievement levels ranging from local class to World Record level. Data will be discussed with reference to the maintenance of performance with age.

*Research supported by SSHRC*

### Exploring Developmental Differences in Sport Commitment

Weiss, W.M.<sup>1</sup>, and M.R. Weiss<sup>2</sup>. <sup>1</sup>University of Northern Iowa; <sup>2</sup>University of Virginia

According to the sport commitment model (Scanlan, Carpenter, Schmidt, Simons, & Keeler, 1993), enjoyment, personal investments, involvement opportunities, attractive alternatives, and social constraints should predict an individual's desire and resolve to continue participation in an activity. Research has shown general support for the sport commitment model among youth and adolescent athletes. The present study sought to extend this knowledge base by examining developmental differences in original and additional sport commitment constructs. Additional constructs included social support, costs, perceived competence, and motivational climate based on recommendations in the literature (Carpenter, 1992; Weiss & Ferrer-Caja, 2002). Competitive female gymnasts ( $N = 304$ ) ranging in age from 8 to 18 years and competing at Levels 5 to 10 completed questionnaires before or after a practice session. Gymnasts were grouped into three age categories based on developmental research (e.g., Horn & Weiss, 1991) and current grade in school: (a) ages 8 to 10 years, (b) 11 to 14 years, and (c) 15 to 18 years. A series of multivariate analyses of variance revealed that the youngest gymnasts reported higher enjoyment, social constraints, perceived competence, and parent and coach social support than older gymnasts. Early adolescent and middle/older adolescent gymnasts reported higher teammate and best-friend intimacy, performance climate, attractive alternatives, and costs than did the youngest gymnasts. Age-related findings were consistent with developmental psychology research in relation to social support, perceived competence, and motivational climate (e.g., Eccles & Wigfield, 1995; Halliburton & Weiss, 2002; Weiss & Smith, 1999). These results indicate that developmental differences should be considered in tests of the sport commitment model.

### The Impact of Repeated Group Performance Profiling on the Intrinsic Motivation of College Soccer Players

Weston, N.\*, J. Graydon, and I. Greenlees. \*University of Portsmouth; University College Chichester

While there has been some descriptive evidence to suggest that performance profiling (Butler & Hardy, 1992) may help maintain or enhance an athlete's intrinsic motivation (IM; Butler & Hardy, 1992; D'Urso, Petrosso, & Robazza, 2002; Jones, 1993), no experimental research has been conducted in this area. The aim of the present study was to determine whether a repeated performance profiling intervention would significantly improve the IM of soccer players. Forty college soccer players were randomly assigned to one of three groups: performance profiling (PP), sport science education (SS), or control (C). Both PP and SS groups met with an experienced sport scientist for one hour on three occasions over a 6-week period. The PP group completed and then monitored their individual performance profiles as suggested by Butler and Hardy (1992). SS participants observed three sport science sessions on flexibility, nutrition, and mental skills in soccer. The C group followed their normal training and competitive season with no intervention. Athletes completed the Sport Motivation Scale (Pelletier, Fortier, Vallerand, Tuson, Briere, & Blais, 1995) prior to being randomly assigned to a group and then following each intervention phase. A  $3 \times 4$  (Group  $\times$  Time) repeated-measures ANOVA revealed a trend toward an increase in IM as a result of the profiling intervention. The three subforms of IM (intrinsic motivation to know, intrinsic motivation to experience stimulation, and intrinsic motivation toward accomplishments) were analyzed via a  $3 \times 4$  (Group  $\times$  Time) repeated-measures MANOVA. The findings suggest that performance profiling over time is useful in significantly improving athlete intrinsic motivation to know.

### **Sport Psychology Consultant Perceptions of the Usefulness and Impacts of Performance Profiling Within a Group Setting**

Weston, N.<sup>1</sup>, I. Greenlees<sup>2</sup>, J. Graydon<sup>2</sup>, and R. Thelwell<sup>1</sup>. <sup>1</sup>University of Portsmouth; <sup>2</sup>University College Chichester

Despite the suggested use of performance profiling (Butler & Hardy, 1992) in a wide variety of sports (Doyle & Parfitt, 1999), no research has systematically evaluated its effectiveness or potential impact in a sporting environment. The aim of the present study was to examine the opinions of British Association of Sport and Exercise Sciences (BASES) accredited sport psychologists as to the usefulness and potential impact of producing athlete performance profiles in a group setting. Six randomly chosen BASES psychologists were initially interviewed to support, refute, and/or extend the existing limited profiling literature. Following an inductive content analysis by three research professionals, higher order themes suggested that profiling may be useful in helping to raise athlete self-awareness; initiating athlete goal setting; monitoring progress over time; facilitating communication, discussion, and interaction within teams; and helping to improve the consultant's understanding of the athlete. The higher order themes were combined with a review of the performance profile literature to produce a quantitative questionnaire. The questionnaire was then used to examine the opinions of a larger number of BASES-accredited psychology consultants ( $n = 56$ ) as to their perceptions of the usefulness and impact of performance profiling. Findings indicated that consultants believed profiling to be useful although they would tend to use the technique only sometimes over the course of a consultancy. Examination of consultant responses indicated that profiling within a group setting would be useful to help provide a basis for goal setting; identify the athlete's strengths and weaknesses; raise athlete self-awareness; facilitate discussion, communication, and interaction within the teams; and helping athletes evaluate how well they are performing. The present qualitative and quantitative findings confirm and extend the existing literature suggesting that performance profiling in a group setting is a useful technique that may impact upon the athlete in a number of ways.

### **Sequence Learning in Children**

Wilde, H., and D. Ammar. Texas A&M University

The effective learning of repeated movement sequences in adults is accomplished by imposing a structure on the individual movement elements such that two or more elements become chunked together into subsequences. The result is that the first element in the subsequence is produced substantially slower than the remaining elements. This is thought to occur because the retrieval and processing related to the production of the subsequence happens during the production of the first element. The remaining elements in the subsequence are produced faster because they are not encumbered with these processing delays. The question of concern in the present study was the degree to which these characteristics of effective sequence productions are present in children of various ages. A failure of younger learners to optimally organize movement sequences could account for age related differences in sequence production speed. The task was to depress a sequence of keys in response to stimuli presented on the computer monitor. Sequence lengths of 4, 8, 12, and 16 elements were repeated in 16 acquisition blocks. Retention and random sequence transfer tests were also assessed. The random sequence transfer was used as a reference to distinguish general improvement from those related to the learning of the sequence. The results indicated that younger children (ages 5 and 6) tended to perform the sequences, regardless of length, slower than the older children (ages 8–14) and college-age participants. Differences in the latter two groups were only found for the longer sequence lengths of 12 and 16 elements. The results are discussed in terms of the working memory capacities of the performers.

### **Integration – Differentiation – Intergration? On the Stability of Motor Performance Across the Lifespan**

Willimczik, K., C. Voelcker-Rehage, and O. Wiertz. University of Bielefeld

Two hypotheses concerning lifespan motor development emerge from a theoretical perspective as well as from an observation on everyday experiences: First, motor abilities increase during childhood and youth, remain constant during adulthood, and show a decline during older adulthood. Second, the structure of personality develops from integration (one dimension) during childhood to a differentiation (multiple dimensions) during adulthood to an integration (one dimension) in old age. Our aim was to empirically test the assumptions of personality psychology for selected motor aspects of personality. To test the first assumption, we must analyze when the development of motor abilities stops increasing, forms a plateau, and starts to decrease. The second hypothesis seems plausible due to the observation that children get a holistic education before they specialize during adolescence. Older people usually differ concerning motor fitness in general, but not within their motor profiles. The two hypotheses were tested in a quasi-experimental large-scale study including 1,204 participants ranging in age from 6 to 89 years. We examined the motor abilities speed, flexibility, and fine and gross body coordination, and the learning ability for the skill of juggling as well as throwing and catching with a lacrosse stick. Overall, the results for the first hypothesis show constant values for the motor abilities already from youth onward, and a decline not earlier than the age of 65. The results of the factor analyses contradict the second hypothesis: A strong differentiation occurs not only in adulthood but already for children and still for older adults.

### **Using a Multilevel Approach to Examine the Relationship Between Task Cohesion and Task Satisfaction in Ice Hockey Players**

Wilson, K., K. Spink, D. Nickel, and P. Odnokon. University of Saskatchewan

Athlete satisfaction has been strongly associated with cohesion for a number of years (Spink, 1995; Spink & Odnokon, 2000; Widmeyer & Williams, 1991). For instance, Spink and Odnokon (2000) found that task cohesion predicted task satisfaction, with cohesion accounting for 51.7% of the total variance in task satisfaction. This was found using the individual as the unit of analysis. Given the recent finding of Spink et al. (2004) that the relationship between task cohesion and task satisfaction is best examined at both the individual and group levels, one wonders whether the relationship found by Spink and Odnokon (2000), which ignored any possible team effects, would change if multiple levels were examined. This study reanalyzed the data of Spink and Odnokon using a multilevel approach (HLM). Elite male ice hockey players ( $N = 194$ ) playing on 10 teams completed the GEQ (Carron et al., 1985) to assess cohesion, and the team integration subscale of the ASQ (Reimer & Chelladurai, 1998) to assess team task satisfaction, during the last week of the regular schedule. Results revealed a significant ICC (.55) for task satisfaction, suggesting that analysis at both the individual and team levels was warranted. The model accounting for the most variance in task satisfaction at both levels included the task cohesion measures of GIT ( $p < 0.001$ ) and Team Mean ATG-T ( $p < 0.001$ ), explaining 69.7% of the total variance, with 33.5% of individual and 99.5% of team-level variance being explained. The fact that the multilevel approach accounted for 18% more variance than the individual level analysis suggests that it should be considered in future studies of this nature.



### **Examining Select Psychometric Properties of the Behavioral Regulation in Exercise Questionnaire-2**

Wilson, P.<sup>1</sup>, W. Rodgers<sup>2</sup>, T. Murray<sup>2</sup>, S. Fraser<sup>2</sup>, and C. McIntyre<sup>1</sup>. <sup>1</sup>Brock University; <sup>2</sup>University of Alberta

Previous research (Mullan & Markland, 1997) suggests that Self-Determination Theory (SDT; Deci & Ryan, 1985, 2002) is a useful framework for understanding exercise motivation issues. The purpose of this study was to examine select psychometric properties associated with scores derived from the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, in press), an exercise-specific measure of SDT's motivational continuum. Participants ( $N = 255$ ) were university students (mean age 20.37 yrs,  $SD = 2.59$ ) who were currently physical active ( $M_{\text{METS}} = 41.96$ ;  $SD = 25.15$ ). They completed the BREQ-2 as well as measures of perceived exercise competence and behavioral intentions for exercise. Confirmatory factor analysis supported the fit of the 5-factor BREQ-2 measurement model,  $\chi^2 = 358.96$ ;  $df = 142$ ;  $p < .001$ ; IFI = .92; CFI = .92; SRMSR = .067; RMSEA = .078 (90% CI = .068 to .088), and the fit of an expanded 7-factor measurement model that included both perceived competence and behavioral intentions with each BREQ-2 factor,  $\chi^2 = 713.81$ ;  $df = 329$ ;  $p < .001$ ; IFI = .92; CFI = .92; SRMSR = .067; RMSEA = .079 (90% CI = .061 to .075). Phi coefficients indicated a quasi-simplex pattern of interfactor correlations between BREQ-2 factors, and internal consistency reliability estimates for all BREQ-2 subscales exceeded .75 (Cronbach  $\alpha$ 's ranged from .79 to .92). Further correlational analyses indicated that amotivation was negatively associated with perceived competence and behavioral intention, while more self-determined identified and intrinsic exercise regulations were positively correlated with perceived competence and behavioral intentions for exercise. Overall, the results of this study suggest the BREQ-2 displays a number of desirable psychometric characteristics that render the scale useful for examining motivational regulations from the perspective of SDT in exercise contexts.

### **The Relationship Between Psychological Need Satisfaction and Self-Perception in Females**

Wilson, P.<sup>1</sup>, W. Rodgers<sup>2</sup>, S. Fraser<sup>2</sup>, T. Murray<sup>2</sup>, and C. McIntyre<sup>1</sup>. <sup>1</sup>Brock University; <sup>2</sup>University of Alberta

Although previous research supports the link between positive self-perceptions and indices of exercise participation and mental health (Fox, 1997), recent research has questioned the mechanisms underpinning self-perception formation (Kowalski et al., 2003). Drawing from Self-Determination Theory (SDT; Deci & Ryan, 1985, 2002), Fox (1997, 2000) contends that satisfaction of the psychological needs for autonomy and relatedness, in conjunction with perceived competencies, represent important facilitators of positive self-perceptions. Thus the purpose of this study was to address the contribution made by each psychological need-satisfaction construct proposed by SDT to account for physical self-worth (PSW) and global self-esteem (GSE). Female undergraduate students ( $N = 178$ ) completed measures of psychological need satisfaction for exercise, PSW, and GSE. Descriptive statistics indicated that participants reported greater satisfaction of competence and autonomy over relatedness needs, and held more favorable global than physical self-perceptions. Hierarchical multiple regression analyses indicated that each psychological need-satisfaction construct contributed significantly to the prediction of both PSW ( $\beta$ 's ranged from .18 to .29;  $R^2_{\text{adj.}} = .39$ ) and GSE ( $\beta$ 's ranged from .15 to .24;  $R^2_{\text{adj.}} = .24$ ). Additional regression analysis indicated that PSW fully mediated the relationship between perceived competence and relatedness for exercise and GSE; however, perceived autonomy retained a direct albeit weaker effect on GSE after controlling for the influence of PSW ( $\beta$ 's changed

from .24 to .20). Overall, these findings supported a link between satisfaction of competence, autonomy, and relatedness needs in exercise and positive self-perceptions, and provided empirical support for SDT's contention regarding the beneficial effects stemming from perceived autonomy in exercise contexts on both physical and global self-perceptions.

### **Image Isn't Everything: Impression Motivation Moderates the Social Physique Anxiety-Exercise Relationship**

Woodgate, J.<sup>1</sup>, A.E. Latimer<sup>2</sup>, M.E. Jung<sup>2</sup>, C.A. Shields<sup>1</sup>, and S.M. Strachan<sup>1</sup>. <sup>1</sup>University of Waterloo; <sup>2</sup>McMaster University

Given the previous inconsistent findings between social physique anxiety (SPA) and exercise, it is possible that other variables moderate this relationship (McAuley et al., 1995). While self-presentation efficacy (SPE) has been identified as a moderator among older women (Angove et al., in press), it is unclear if this finding generalizes to younger populations. Although additional self-presentational constructs, such as impression motivation (IM), may moderate the relationship between SPA and exercise, this possibility has not been examined. Thus the purpose of the current study was twofold: (1) to examine whether SPE is a moderator among young women; and (2) to determine whether IM also moderates the SPA-exercise relationship. Active young women ( $N = 111$ ;  $M$  age 21.5 yrs) completed the SPA scale (Martin et al., 1997), a measure of SPE in exercise settings (Gammage et al., in press), and an IM scale (Conroy et al., 2000). Objective exercise attendance was monitored prospectively over the subsequent 8-week period. Using hierarchical linear regression analyses, SPE and IM were examined as moderators of the SPA-exercise relationship. The overall model was significant,  $R^2_{adj} = .08$ ,  $F(6, 105) = 2.63$ ,  $p < .02$ . Only IM interacted with SPA to explain a significant amount of variance in exercise attendance,  $R^2$  change = .06,  $p < .01$ . Accordingly, IM and not SPE moderated the SPA-exercise relationship among young women. Post-hoc analyses of this significant interaction term (Aiken & West, 1991) indicated that SPA was positively correlated with exercise only for women with low IM scores,  $p < .01$ , and was unrelated to exercise for women with high IM. These findings suggest that SPA is a motivator of exercise behavior, but only for young women who have few concerns about being perceived as an exerciser.

### **Extended Random Practice Reduces the Rate Effect as Well as the Sequence Length Effect**

Wright, D., C. Magnuson, C. Shea, and W. Verwey\*. Texas A&M University; \*University of Twente, The Netherlands

Motor programming improves with random practice. Revealing a reduction in the difference in RT for short and long movement sequences (i.e., sequence length effect) with extended random practice supports this claim. Moreover, the sequence length effect remains small after random but not blocked training for at least 24 hrs. The present work assessed whether improvements in programming through random practice are ubiquitous by examining a related programming effect—the rate effect—which refers to the finding that mean element time increases as a function of the number of elements in a sequence. Specifically, we asked whether a greater reduction in rate effect would occur after blocked or random practice. Individuals practiced four movement sequences of either 2 or 6 elements in a random or blocked schedule for 2 days, followed by a test on Day 3. With either blocked or random practice the rate effect was reduced from ~190 ms to <50 ms. The emergence of the rate effect was primarily due to the relatively long latency of one of the middle elements in the longer sequence, which has been interpreted as including a cost for concatenating motor chunks. In the test phase, the rate effect was smaller for random-practice

participants because of a smaller cost of concatenating motor chunks *and* faster execution of the elements within chunks compared to their blocked-practice counterparts. These programming and execution benefits through random practice are in addition to the concomitant improvement in sequence initiation.

### **An EEG Coherence Study on Basketball Free Throw**

Wu, C-T., J-H. Lin, D-Y. Fong, Y-J. Chen, and T-M. Hung. Taipei Physical Ed College

This study examined the relationship of the cortico-cortical communication between good and poor performance of the basketball free throw. Previous studies have suggested that coherence decreases during the aiming period of a shooting task. As such, successful free throw performance in the present study was predicted to exhibit less cortico-cortical communication (i.e., lower coherence), especially between cognitive and motor areas, compared to the failed free throw. Participants were 12 male skilled basketball players who were required to make at least 50 baskets. Electroencephalographic (EEG) time series were recorded for both successful and failed free throws. These EEG data were segmented into four 0.5-s epochs of the last 2 seconds prior to initiation of the free throw. Coherence was extracted from three frequency bands (low alpha, 8–10 Hz; high alpha, 10–13 Hz; low beta, 13–22 Hz) using sites Fz, T3, T4, P3, and P3. A  $2 \times 4 \times 2 \times 2$  (Performance  $\times$  Epoch  $\times$  Hemisphere  $\times$  Electrode) ANOVA with repeated measures on all four factors was employed on coherence of three frequency bands separately. Results revealed that compared to the failed throw, the successful throw showed significant lower coherence at all three frequency bands. Coherence for low-alpha between parietal (P3, P4) and frontal (Fz) regions in the left hemisphere was lower than in the right hemisphere. Additionally, the significant epoch effect showed that coherence for high alpha and low beta was lower when participants approached ball release. These results suggests that (1) compared to the failed throw, brain activity during a successful throw engages in less cortico-cortical communication between the planning premotor region (Fz) and the cognitive temporal and parietal regions, which implies decreased involvement of cognition with motor processes. (2) The parietal region exhibits low coherence in the left hemisphere, which implies the specialization of cortical function in brain cortex during planning a task. (3) As time approaches for the free throw, brain activity shows more autonomy, as revealed by a decreasing EEG coherence.

### **To Dictate or Not: The Exploration of a Self-Regulated Practice Schedule**

Wu, W., and R. Magill. Louisiana State University

Schunk and Zimmerman (1994) have defined self-regulated learning as the degree to which individuals are metacognitively, motivationally, and behaviorally active participants in their learning process. Self-regulation has played a significant role in motor skill learning. For example, research has shown that skill learning is facilitated when learners are given the opportunity to choose when they will receive augmented feedback during practice. Much like augmented feedback research, practice schedule research has primarily consisted of predetermined practice environments; the experimenter or instructor not only dictates the amount of practice but also the type of skills to be learned. Thirty novice participants were randomly assigned to either a self-regulated or yoked condition in which they performed 90 golf putts from 3 distances: 1.5, 3, and 4 feet. Those in the self-regulated group chose the putting distance on each trial during the practice trials. Results of the study showed that the self-regulated group who got to choose each trial during practice performed better than the yoked group during both a 5-min and 24-hr serial transfer test. Results suggest that actively involving learners during practice by giving them the ability to structure the scheduling of practice trials can produce learning processes that enhance motor skill learning.

### **Attentional Focus Effects on Motor Performance as a Function of Level of Expertise**

Wulf, G., M. Landers, J. Mercer, T. Toellner\*, and M. Guadagnoli. University of Nevada Las Vegas; \*University of Jena

The performance and learning of motor skills has been shown to be enhanced if the performer is instructed to adopt an external focus of attention, compared to an internal focus or control conditions (see Wulf & Prinz, 2001, for review). In the present study we asked whether the effects of attentional focus would vary as a function of the performer's level of expertise. In two experiments, participants were required to stand as still as possible on an inflated rubber disk under either external focus (disk) or internal focus (feet), and control conditions. Participants in Experiment 1 were world-class balance acrobats (experts) and young adults (nonexperts), whereas older adults with Parkinson's disease (PD) participated in Experiment 2. The results showed that, for experts, postural stability was greatest under control conditions, while no attentional focus effects were found for nonexperts (presumably because the task was not challenging enough). However, for those with PD, adoption of an external focus resulted in enhanced postural stability. These results suggest that the optimal focus of attention depends on the level of expertise. The findings are discussed in terms of levels of action control, which change with the performer's experience level.

### **Reexamination of Discharge Rate Effect on Motor-Unit Synchronization and Force Production in Simulated Muscle Contractions**

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Motor-unit synchronization was considered to be an important factor to affect muscle strength (Milner-Brown et al., 1975). However, research (Yao et al., 2000) indicates that the relationship between the MU synchronization and muscle strength may not be a causal one. A recent study by Yao (2000) further tentatively showed that both MU synchronization and muscle strength were affected by another factor, such as MU discharge rate (DR). Yao's study was limited to the observation of the simulated muscle contractions at only three high-excitation levels, i.e., 60%, 80%, and 100% of maximum muscle contraction. It is unknown whether DR at lower excitation levels of muscle contractions will affect MU synchronization and muscle strength the same as at higher excitation levels. The purpose of this study was to examine the effect of DR on MU synchronization and force production in simulated muscle contractions at a large range of excitation levels. Muscle strength was simulated by using a model from Fuglevand et al. (1993) at 10 excitation levels ranging from 10% to 100% of maximum, and two DR levels, low and high (max discharge rate = 35 and 45, respectively). The MU synchronization was estimated by a Binomial-Poisson method (Yao et al., 2000). The results demonstrated that DR had significant effects on MU synchronization and muscle strength across all excitation levels. That is, the higher DR produced greater MU synchronization and muscle strength. These findings further suggest that the relationship between MU synchronization and muscle strength may not be a causal one. DR is an important factor that causes increases in both MU synchronization and muscle strength.

### **Motivation for Physical Activity in Children: Instrument Validation in the MCG FitKid Project**

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Understanding human motivation to engage in physical activity has been a major focus of exercise psychology research for the last 30 years. However, there is a sparse pool of instruments for assessing motivational processes in children. The Pictorial Motivation

Scale (PMS) was originally developed for use with adolescents with intellectual disabilities and has four 4-item subscales: Intrinsic Motivation (IM), Identified Regulation-External Motivation (IR), External Regulation-External Motivation (ER), and Amotivation (AM). The purpose of the present study was to examine the psychometric properties of the PMS in children without intellectual disabilities. The PMS was selected due to its simple language and pictorial representations of motivational constructs. It was administered to 498 third-graders (mean age  $8.7 \pm .56$  yrs; 169 white, 332 black; 239 boys, 259 girls; 68% eligible for free/reduced school lunch) at the beginning of the fall semester. Results showed that black children had significantly higher scores than white children for ER (8.3 vs. 7.5) and AM (5.8 vs. 5.2), both  $p < .001$ , and boys had higher ER than girls (8.39 vs. 7.67),  $p < .001$ . Cronbach's alpha (IM = .50, IR = .48, ER = .53, AM = .60) and corrected item-total correlations (IM = .22-.37, IR = .22-.32, ER = .14-.40, AM = .35-.41) were calculated for each of the four subscales. With respect to concurrent validity, the subscales were significantly correlated with other measures of physical activity motivation such as task orientation (IM = .18, IR = .15, AM = -.31, all  $p < .01$ ), ego orientation (ER = .26, AM = .17, all  $p < .01$ ), and enjoyment (IM = .33, IR = .26, ER = -.10, AM = -.32, all  $p < .03$ ). These findings suggest that further refinements are necessary to the PMS for use with young children, but that the cognitive motivational constructs measured by the scale may indeed manifest themselves as early as 8 years of age. Results will be discussed in the context of developmental and comprehension issues and their possible effects on the validity of the PMS.

### **Generalized Muscle Moment and Spatial Inconsistency in Rapid Aiming Movements**

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Numerous models propose that an increase in muscular force production (or neuromuscular noise) leads to greater spatial inconsistency in rapid aiming movements. However, most evidence comes from the studies concerning movement amplitude and duration. Thus the present study further examined spatial inconsistency in rapid aiming movements by differentiating limb dynamics while keeping limb kinematics constant. Seven participants performed 80-cm hand-held stylus movements to a target 3 cm in diameter with fixed MT of 450-550 ms. Movements were made with their left hand in the vertical plane while lying on their left or right side, thus either (a) downward movements with gravity (DM), or (b) upward movements against gravity (UM). Limb movements were videotaped at 250 Hz to calculate within-participants variability in joint angles as well as generalized muscle moment (GMM) at the shoulder and elbow joint. Results showed no statistically significant movement outcomes (i.e., MT and RMSE) between DM and UM. Moreover, nearly identical limb kinematics (i.e., angular displacement, velocity, and acceleration) was found. However, limb dynamics were specific to gravity: greater GMM for UM in the acceleration phase, whereas for DM in the deceleration phase. Multiple regression models with integrated GMM fairly accounted for increased within-participant variability in joint angles (adjusted  $R^2 = .610$  for shoulder; .479 for elbow). These findings clearly demonstrate that spatial inconsistency in rapid aiming movements is dependent on muscular force production, regardless of movement amplitude or duration.

### **The Accuracy of Visuomotor Mapping With a Tool**

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According to Jeannerod, prehension coordinates grasp and transport components that are calibrated by visual cues to different object properties through separate visuomotor channels; visuomotor transformations have been demonstrated with high accuracy when conducted within a single visuomotor channel (Jeannerod 1981, 1984; Jeannerod & Decety,

1990). In this experiment we studied how the visual cue of object size is used to shape the end-effector of a tool. We also examined whether arm transport interferes with hand grasping and the influences of tool use on both grasp and transport components. Eight university students were recruited as participants, to whom computer-generated graphic cubes of different sizes (8, 16, 24, and 32 mm) were randomly presented. They were required to grasp the graphic cubes either statically or reaching a distance of 10 cm. In tool conditions, a grasper with a changeable hinge location was attached to the thumb and index finger. Peak aperture was computed from the valid data of 7 participants. The correlation coefficient between peak aperture and object size was calculated for each experimental condition. Results showed that peak aperture increased as object size increased. The highest correlation was found in the condition using the natural hand in the static arm position. Adding arm transport slightly reduced the correlation between peak aperture and object size, which challenges the notion of independent visuomotor channels. When a tool was used, the correlation between object size and peak aperture measured at the tips of the grasper was reduced significantly, reflecting the difficulty of mapping sensory input to the motor output at the ends of a tool. However, tool hinge location did not change grasping performance, which indicates that the mechanical properties of the tool were taken into account in the control of remote manipulation.

### **The Effect of Practice on Task Switching Performance**

Zhu, Q., and J.B. Shea. Indiana University

The performance of essential life skills requires that one be able to switch from one task to a second task. This switch has been found to cause a decrement (switch cost) in performance of the second task, even when it is well known and the individual is prepared for the switch (Meiran, 1996). Previous studies have used stimulus categorization protocols to look at the cost of switching between tasks that require different decisions; however, fewer studies have looked at the cost of switching between tasks that require different motor responses. In addition, the effect of practice on task switching has never been examined. The current study involved two key-pressing tasks (Tasks A and B), and the effect of practice on the cost of switching between these tasks was examined with respect to both reaction time (RT) and movement time (MT). Two preswitch practice schedules were adopted: the preswitch six (PS6) schedule in which 6 trials in Task A were administered before Task B was introduced, and the preswitch one (PS1) schedule in which one trial in Task A was administered before Task B was introduced. These practice schedules were administered to two groups such that one group (PS6-PS6) received PS6 in early and late practice while the other group (PS1-PS1) received PS1 in early and late practice. The total amount of practice for Tasks A and B was equal during practice for both groups. Performance on the first trial of Task B was used to examine the cost of switching from Task A. Findings showed that RT for both PS6 and PS1 practice schedules was lower late ( $M_{PS6} = 1008.67$  ms;  $M_{PS1} = 745.00$  ms) in practice than early ( $M_{PS6} = 2772.33$  ms;  $M_{PS1} = 3889.33$  ms) in practice. This indicates that practice of both tasks may lower the switch cost on response planning for a motor task, and that increased preswitch practice of a task does not affect this cost. Findings for MT showed that the switch cost for the PS6 practice schedule was greater late ( $M = 1986.67$  ms) in practice than in early ( $M = 1586.33$  ms) practice. In contrast, the switch cost for the PS1 practice schedule was lower late ( $M = 1024.67$  ms) in practice than in early ( $M = 1627.00$  ms) practice. In addition, PS6 and PS1 schedules represented the switch cost in RT and MT the same in early but different in late practice, with PS6 greater than PS1 in late practice. These findings indicate that with the practice of both tasks, increased preswitch practice of one task may slow the online control of the response for the second task.

### **Learning and Transfer of a Relative Phase Pattern and an Absolute Amplitude Pattern Through Observation**

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The coordination dynamics of observational learning and transfer were examined in a multijoint coordination task. Observers watched an individual physically practice a flexion-extension motion of the elbow and wrist in an attempt to produce a vertically oriented elliptical trace on a computer screen. Physical performance of the task required a 90° relative phase relationship (temporal) between elbow and wrist flexion/extension motions and an amplitude ratio (spatial) of 0.6 representing larger elbow motion compared to wrist motion. Physical participants practiced for 2 days and received both concurrent and terminal feedback. Observers were instructed to watch the movements of the physical participant as well as the feedback provided. For the physical-practice participants, three findings demonstrate learning: (1) a shift in mean relative phase from 57 to 80° (10° off the target phase); (2) relative phase variability decreased from 40 to 24° from Day 1 to Day 2; (3) the amplitude ratio shifted from 1.13 to .84 from Day 1 to Day 2. The Day 3 retention tests demonstrated that the physical practice group maintained the relative phase pattern and amplitude ratio achieved on Day 2, with 80% of the observers producing a similar relative phase pattern without any feedback or physical practice. However, the amplitude ratio for the observers was significantly farther from the required 0.6, with consistently larger wrist amplitudes (vs. smaller) than elbow amplitudes. Thus, without physical practice the observers were unable to meet the spatial requirements of the task. Physical-practice individuals, in general, were characterized by effector-independent transfer of relative phase, as were many of the observers under a variety of transfer tasks. Moreover, both physical practice and observers were able to modulate the required amplitude ratio under a variety of transfer conditions, demonstrating independence in control of the temporal and spatial variables of the task.

### **Relationship of Physical Activity With Neurocognitive Functioning During an Executive Function Task in Older Men and Women**

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Cognitive function has been demonstrated to decline with age. In particular, such age-related decline is pronounced in the frontal lobes that mediate executive mental processes. Cerebral cortical activity underlying basic executive function can be measured by event-related potentials (ERP) extracted from continuous EEG (Polich, 1996). The latency of the P300 component typically increases with age while amplitude decreases with age. In light of the evidence provided by Kramer et al. (1999) that physical fitness preserves executive function, we examined frontal ERPs during executive challenge (response inhibition task). Volunteer adults ( $N = 78$ ) ages 66–92 residing in a suburban retirement community completed an auditory go/no-go protocol. They completed the Yale Physical Activity Survey (YPAS) to determine weekly Kcal expenditure from physical activity ( $M = 5,232 \text{ kcal} \pm 2,684$ ). Continuous EEG was recorded from 9 sites according to the International 10–20 system. Electrode placement included left, right, and midline frontal, central, and parietal sites. P300 average amplitude and latency in response to the no-go stimulus (20% occurrence probability) was regressed on age and weekly Kcal expenditure. Multiple regression analysis revealed a significant relationship between P300 amplitude and physical activity at site F3 during the no-go task,  $F(2, 74) = 3.61, p = .032$ . In summary, physical activity appears to have a specific preservative effect on executive function in the frontal cortex.